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THESIS



IMPLEMENTATION AND EVALUATION OF AN ASYNCHRONOUS GROUP MEMBERSHIP PROTOCOL

by

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December, 1993

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Implementation and Evaluation of an Asynchronous Group Membership Protocol

by

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Submitted in partial fulfillment of the requirements for the degree of

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ABSTRACT

A group membership protocol provides the mechanisms to ensure the consistent group views among a group-oriented distributed processes. The protocol is required to dynamically re-configure the group views among the various members in the event of a change to the group due to a new member joining or a member departing. The departure may be voluntary or involuntary. The protocol must provide a scheme to detect the failure of any of the members and re-configure the group. Multiple changes to the group must be perceived at all members in the same order.

This thesis deals with a particular group membership protocol. The protocol structures the group as a logical ring. Changes to the group are accomplished using a two-phase scheme. The agreement phase consists of circulation of an *agree* token. Processing the token makes a pending change known to all members. The commit phase incorporates the changes in the correct order.

This thesis presents an implementation of this asynchronous group membership protocol. The main feature is that the decentralized nature of the protocol eliminates the need for a dedicated coordinator of changes. The processing requirements for the protocol are likewise distributed. The processing time required to implement a change to the group is shown to have a linear relationship to the group size.

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I. INTRODUCTION

A. BACKGROUND

1. Distributed Computing

Distributed computing is at the forefront of today's computing research. The increased reliability and performance has resulted in distributed computing being used in various applications such as distributed control applications, distributed databases, and real-time settings [1]. The need for fault-tolerant systems is particularly important to military applications. Such applications typically require fault tolerant algorithms, real-time response, on-line reconfiguration, and other schemes to increase reliability. These requirements, however, lead to significant additional complexity. This complexity arises in part due to the reliable inter-processor communication required to implement the distributed processing. Networks are inherently unreliable and make reliable application level message passing a non-trivial task. One of the primary requirements of reliable distributed applications is a reliable multicast communication primitive. A group membership protocol simplifies the construction of a such a primitive [2].

2. Group Membership

Cooperating processes constituting a single application share resources and constitute a process group. Underlying the consistent behavior of such a group is the requirement that all members of the group have implicit knowledge of all other members in the group. Additionally, all members must perceive changes to the group in the same order. Group membership will change as processes join or depart the group. Departures may be voluntary or involuntary as in the case of a failure. An additional requirement is the timely detection of members failing. In order to enhance the robustness of the system, intra-member monitoring must occur. This can be a simple exchange of messages indicating that the process being monitored is still "live."

Historically, protocols solving the group membership problem have been of a centralized design. One member acted as the group host and had the responsibility of monitoring all subordinate members. All changes were detected by the host. Upon a change to the group view, the host broadcast the new group view to all members of the group. Obviously, problems can arise if the host itself fails. Voting must occur in order to elect a new host with the added overhead associated with the voting. Additionally, the processing requirements are unequally distributed between the members of the group as the host takes a major share of the load.

B. SCOPE AND CONTRIBUTION

In this thesis, an implementation of the decentralized asynchronous membership protocol is presented. The protocol was originally presented in [3] and [4]. It was further refined and partially implemented in [5]. This thesis presents a brief overview to the protocol. A more detailed explanation of the protocol and definitions can be found in [5]. This thesis covers additional refinements to the protocol necessary to correct flaws discovered in the coding and testing phase of development. Additionally, the performance of the protocol on an Ethernet Local Area Network (LAN) is presented and discussed.

C. ORGANIZATION OF THE THESIS

The thesis is divided into six chapters. Chapter II presents an overview of the basic operation of the protocol. Chapter III discusses the changes required to implement improvements to the protocol. Chapter IV covers possible further refinements to the protocol. In Chapter V, the performance of the current protocol is analyzed. Chapter VI presents the analysis and possible future areas of research. The code developed is included in the Appendix.

II. GROUP MEMBERSHIP PROTOCOL

In this chapter, the group membership protocol (GMP) is described. The original protocol was presented in [3] and further developed in [5]. This chapter presents an overview of the protocol.

A. GROUP MEMBERSHIP PROTOCOL OVERVIEW

1. Assumptions

The following assumptions are made by the GMP in order for proper implementation. A fully-connected network of reliable First-In / First-Out (FIFO) communication channels connecting operational members is assumed. All failures are assumed to be *crash* or *fail-stop*[6]. This implies that a message sent will be delivered unless the recipient has failed. However, there is no upper bound on the time of delivery.

Multiple changes to the membership are allowed simultaneously. However, the changes are committed one at a time and in the same order at all members.

A member is added to the group when a *join* is processed and is removed when a *failure* is perceived.

The group name is assumed to be public. Those elements that may wish to become members by joining the group have access to the group file which contains the current group view. A prospective member searches for the file on a given site. The group view is extracted and the prospective member sends the *joinreqst* to the appropriate address.

The protocol maintains three main databases at each member; the membership list (group view), status table and token pool. Each has a separate database manager to ensure mutual exclusion to all processes needing the services of the database.

2. Overview

The GMP guarantees that the group view changes occur in the same relative sequence at all operational members of the group.

The most significant feature of the GMP is the decentralization. No single member is responsible for detecting a change to the membership nor guaranteeing group view consistency among the group members. A logical ring is used to implement both of these functions in a distributed manner. The logical ring is a circular ordering of the members of the group.

The physical location of the member has no relation to the ordering of the logical ring. Within the ring structure the direction of traversal was arbitrarily chosen as clockwise. Given the structure each member only monitors its anti-clockwise neighbor, the acwnbr. The acwnbr responds to a status query, statusqry, with a status report, statusrpt. Likewise, it sends a statusqry to its acwnbr. Thus, every member monitors only one other member of the group and is itself monitored by it clockwise neighbor, cwnbr.

Consider a five member group. Process p_0 was the initial member of the group. The other members joined in an order such that p_0 is the *acwnbr* of p_1 , p_1 is the *acwnbr* of p_2 , and so on. Member p_1 sends a *statusqry* to p_0 , which responds with a *statusrpt*. Likewise, p_2 sends a *statusqry* to p_1 . This is illustrated in Figure 1. For clarity, only the monitoring and response is shown for the first set of neighbors.

The ring configuration changes as the group membership changes. The ring starts as a single member group with other members joining in some arbitrary order. All changes to the group are treated in a similar manner. Members wishing to join an existing group read the group membership file in the first active member located on the net. The joining member then sends a *joinreqst* to the first member of the group. If the initial parameters message, *initparams*, is not received in a reasonable time, the request is transmitted to the next member in the group view file until all members have been attempted or a successful join has been completed.

A failure is considered an involuntary departure. When a member departs the group voluntarily, it simply stops responding to *statusqrys*. It will then be perceived as failed and subsequently removed from the group. Delayed transmission of the *statusrpt*,

failure of the member to respond to the *statusqry* and a lost *statusrpt* will all result in the monitored member being detected as failed.

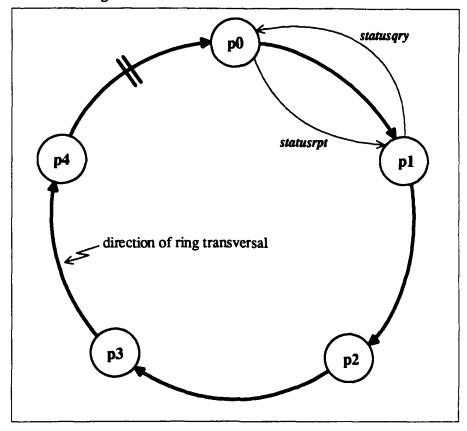


Figure 1 A Logical Ring

3. Processing of Individual Changes

The GMP allows for a two phase procedure for all changes to the group view, the agree phase and the commit phase. An agree token is circulated around the ring. Once the originator receives the token via the ring, all members have processed the agree token. At this point the agree token is converted to a commit token, and the change agreed upon is committed by each member as the token is circulated around the ring. The protocol ensures that each token is received by all members, processed only once, and never lost. More complete descriptions of the actions required by the different phases is covered in the following section.

a. Departure Processing

Once a member perceives the departure of its acwnbr, voluntary or otherwise, a failagree token is initiated. The failed member is added to the status table with a failagree status. The token is incorporated into the token pool and transmitted via the FIFO channel to the cwnbr. Similar processing occurs at members receiving a failagree token for the first time. Once the token has been received by the originator, the agree phase has been completed. The failed member is removed from the status table and group view. The token pool is purged. The failcomit token added to the token pool and transmitted around the ring. When a member receives a failcomit token for the first time, similar processing occurs.

b. Join Processing

The protocol maintains a logical marker between the first and last members to join the group. The first member is called the host. A new member will always join the group as the acwnbr of the host. The host has the responsibility of initiating the joinagree token for the new member. However, the host may not be the member of the group that receives a join request message from the new member. In this case, the message is converted to a token, forwarded, and the new member is added to the status table. Once the host has received either a joinreqst token or message, it initiates a joinagree token. The host then adds the token to the token pool, the member to the status table, and transmits the token to its cwnbr. Similar processing occurs when a member receives a joinagree token for the first time. When the host receives the joinagree token via the token ring, it initiates the commit phase.

The *joincomit* phase consists of purging the token pool, incorporating the joincomit token in the token pool, adding the new member to the group view, and forwarding the token. Additionally, the host will transmit the status table, group view, and token pool to the new member in the initial parameters message, *initparams*. This is accomplished by *IntegrateMember*.

III. PROTOCOL CHANGES

This chapter describes the revisions to the group membership protocol proposed in [5]. Modifications discussed include lost messages, delayed transmission, lost token acknowledgments, and proper termination of the agree phase.

A. LOST INITIAL PARAMETERS MESSAGE

1. Problem

Consider a lost initial parameters *initparam* message. After the *initparam* message is sent, the joining member is regarded as part of the group by the sender even if it is lost. However, the group membership, token pool and status table are not accurately reflected in the joining member's local database. There was no mechanism for re-transmission of the *initparam* message, nor was it possible to recreate the information locally.

2. Solution

The status reporter is required authenticate the group membership. Reports are generated in response to status queries from only those members that are in the group or are joining the group. Status queries from outside the group are ignored. See Figure 2.

```
ReportStatus process at p<sub>i</sub>

1 if (not blocked by IntegrateMember)

2 if (querying member ∈ GV<sub>pi</sub> or has joinagree status)

3 p<sub>mon</sub> = querying member

4 send status to p<sub>mon</sub>

5 if (previous querying member = p<sub>mon</sub>)

6 send TokenPool(p<sub>i</sub>) to p<sub>mon</sub>

7 end

8 end

9 end

end ReportStatus
```

Figure 2 Reporting of Status

3. Justification

A lost *initparam* message will result in the new member failing to respond to the host's first *statusqry*. Upon time out, the new member will be considered a failed process. The host's original *acwnbr* will then be monitored anew by the host. The new member, never having received the *initparam* message will time out on the join request. It will then attempt to join again.

By the time the *initparam* message is transmitted, the host's original *acwnbr* has knowledge that the new member is now joining the group. Therefore, with this change, the host's original *acwnbr* issues status reports to the new member's queries.

4. Side effects

Such group authentication will prevent multiple switching of the *cwnbr*. If the *initparam* message is lost, the host's original *acwnbr* will be un-monitored for a short time. Upre the failure detection of the new member, the host's original *acwnbr* will again be monitored by the host process. To ensure that the *StatusReporter* responds only to members within the current group view, *IntegrateMember* must be atomic with respect to *StatusReporter*. This will prevent race conditions when *initparam* message is received, followed by an almost simultaneous receipt of the first status query from the host process. Figure 3 shows the process dependencies, while Figure 4 depicts the specification for *IntegrateMember*. The inter-process dependencies for the monitor processes are shown in Figure 5.

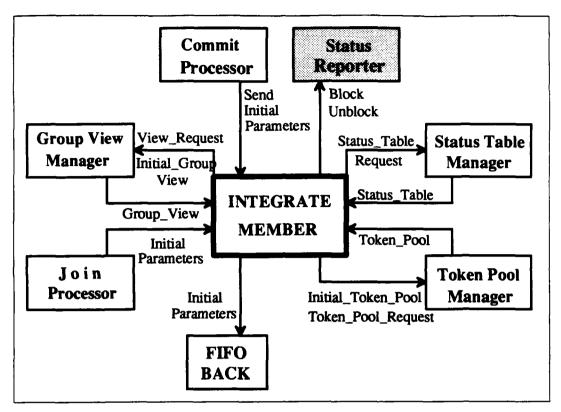


Figure 3 Integrate Member - Process Dependencies

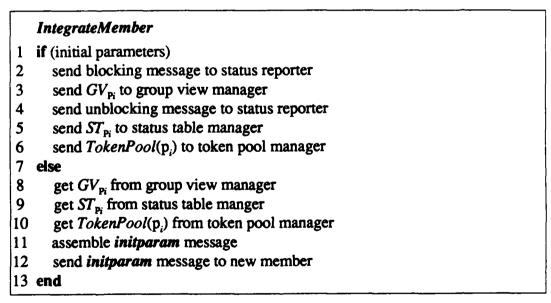


Figure 4 Integrate Member Process Specification

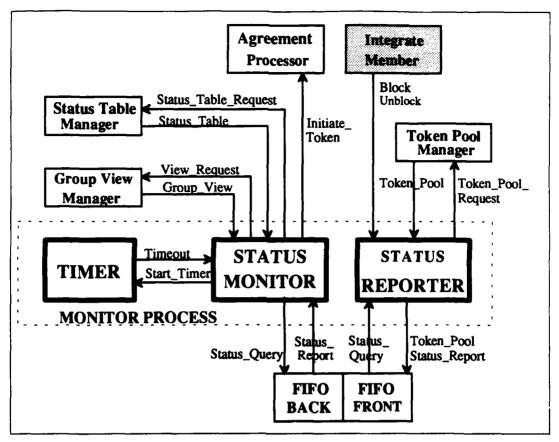


Figure 5 Monitor Process - Internal Structure and Dependencies

B. DUPLICATE PROCESSING

1. Problem

The protocol was designed for processing in a member to be concurrent. Consider AgreeProcessor and ComitProcessor. It is possible for the AgreeProcessor to receive an agree token immediately followed by an external token pool containing the same token. The token may be converted to a commit token and forwarded to ComitProcessor. Due to context switching, processing of the commit token may not be immediate. Further, AgreeProcessor begins processing the token pool which contains the copy of the original agree token. Since the processing of the commit token has not occurred, it is possible for the agree token from the token pool to be detected as requiring

conversion. The subsequent processing of the duplicate commit is an error. Figure 6 depicts the problem.

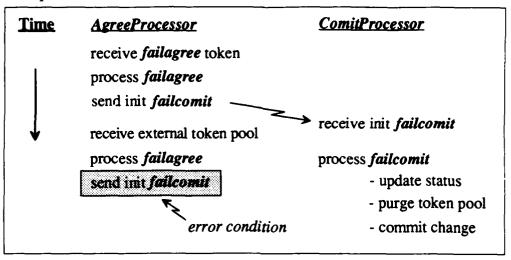


Figure 6 Error Condition Arising from Asynchronous Programs

2. Solution

In order to solve this problem, *CommitProcessor* must be atomic with respect to *AgreeProcessor*. (see Figures 7 and 8)

3. Justification

Both processors use the same databases. Rejection of duplicate tokens depends upon the current state of the databases. Since token rejection is accomplished by AgreeProcessor, and ComitProcessor updates the state to reflect the commit in progress, AgreeProcessor must not begin its next iteration until ComitProcessor has updated the state. ComitProcessor does not fully update the state until just prior to transmitting the commit token around the ring. Refer to Figure 9, lines 1-3.

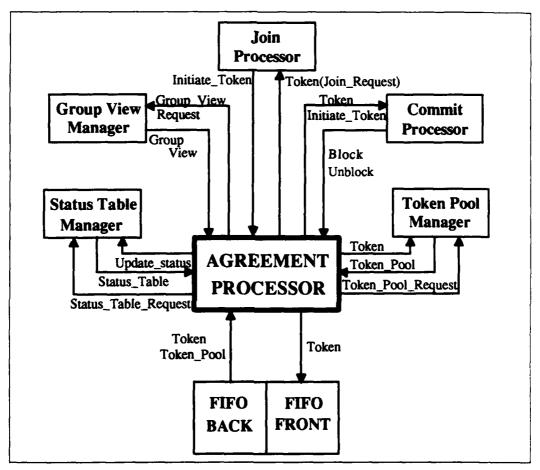


Figure 7 Agreement Processor - Process Dependencies

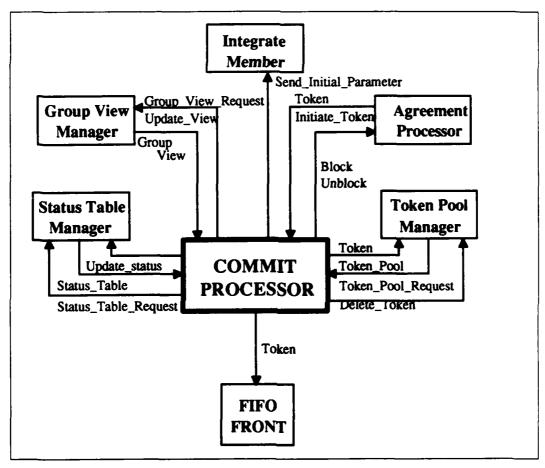


Figure 8 Commit Processor - Process Dependencies

```
CommitChange for commit<sub>pi</sub>(p_k) at p_i
    /* Depending on whether a join or departure */
1 add or delete p, from GV_{p_i}
2 delete p_k entry from ST_{p_i}
|3 \quad vn(p_i) \leftarrow vn(p_i) + 1
4 delete all commit tokens received before agree<sub>Pi</sub>(p<sub>k</sub>) from TokenPool(p<sub>i</sub>)
    if (join committed && joinreq_{p_i}(p_k) \in TokenPool(p_i))
6
       delete joinreq_{p_i}(p_k)
7 end
8 add commit_{p_i}(p_k) to TokenPool(p_i)
9 delete agree<sub>pi</sub>(p<sub>k</sub>)
10 if (current host = p_{i})
        determine new phost
11
12 end
13 if ((join committed) && (p_{host} = p_i))
        send ST_{p_i}, TokenPool(p_i), and GV_{p_i} to acwnbr(p_i)
15 end
16 send commit<sub>p</sub>(p<sub>k</sub>) token to cwnbr(p<sub>i</sub>)
   end CommitChange
```

Figure 9 Actions for Committing a Change

C. INVALID DELETE TOKEN

1. Problem

An attempt to delete a nonexistent *joinreqst* token from the token pool would result in an error condition and would hang the process. The *joinreqst* token is not always present in the token pool. The token occurs only if a joining member has made the request to a member that is not the host.

2. Solution

Before attempting to delete the *joinreqst* token, the token pool is checked. If the token is present, it is then deleted. Figure 9, lines 5-7.

3. Justification

This is a special case token, and does not always occur in all token pools. Exception handling as above will correct any inconsistencies among the various token pools.

D. LOST TOKEN ACKNOWLEDGMENT

1. Problem

If the token acknowledgment is not received by the sending *front* process, the token will remain on the queue. It will be re-transmitted every time that *front* receives a message. The original token will be processed at the receiving end and further receipts of the rame token will be detected as duplicates and discarded. The problem lies in that the queue is never cleared. Therefore, subsequent tokens will be blocked behind the token for which the acknowledgment was lost, unless a failure of one of the two members occurs.

2. Solution

This problem is solved by checking the serial number of the message on the receiving end of the FIFO channel. If the message is the last token received, the token acknowledgment is re-transmitted.

3. Justification

If the message received is the expected token, an acknowledgment is sent. The token is forwarded to the appropriate internal sub-process. If the last token received is received again, a token acknowledgment is sent back and the duplicate token is discarded. This mechanism will account and correct for lost token acknowledgments. Figure 10, lines 17-19.

```
FIFO Channel - BACK process
1 Wait for a channel ready to ready
2 if (internal channel ready)
     if (Status Query)
       update acwnbr
        send Status Query
6
   else if (Initial Parameters)
7
        update acwnbr
8
        send Initial Parameters
     else if (Join Request)
10
        send Join Request
11
     end
12 else /* external channel ready */
13
     if (message originator = acwnbr)
14
        if (Status Report)
           send Status Report to MONITOR_PROCESS
15
       else if (Token)
16
17
           if (Serial Number = Expected_Serial_Number - 1)
18
             send Token Ack /* to acwnbr */
19
           end
20
           if (Serial Number = Expected Serial Number )
21
             send Token to AgreeProcessor
22
             send Token Ack /* to acwnbr */
23
             increment Expected Serial_Number
24
          end /* out of order messages are discarded */
25
       else if (Token Pool) /* Token_Pool is always accepted */
26
           send Token Pool to AgreeProcessor
27
           send Token Ack /* to acwnbr */
28
          set Expected Serial Number = Serial Number + 1
29
       end
30
     end
31 end
```

Figure 10 FIFO Channel - Back Process

E. AGREEPROCESSOR

The specification for the AgreeProcessor was rewritten to account for various subtleties and to improve overall readability. All tokens received through the FIFO channel layer are sent to AgreeProcessor for dispatching to the appropriate processor. A

duplicate token is one that has been previously processed at given member. Some scheme to detect and reject duplicate tokens is required. Proper termination of the *agree* phase and subsequent initiation of the *commit* phase are also required. Figure 11. In this section, we discuss the operation of the *agree* processor.

```
AgreeProcessor for agree<sub>p</sub>(p<sub>k</sub>) at p<sub>i</sub>
1 if (not blocked by CommitProcessor)
      if (initiate agreement message received) /* p_i = p_i */
3
         add agree<sub>p</sub>(p<sub>k</sub>) to TokenPool(p<sub>k</sub>)
4
         ST_{p_i}(p_i) \leftarrow joinagreed \text{ or } failagreed
5
         send agree<sub>pi</sub>(p<sub>k</sub>) to cwnbr(p<sub>i</sub>)
6
        send acknowledgment to calling process
7
      else /* a token or external token pool is received */
8
          if (ExtTokenPool)
9
             for \foralltokens \in ExtTokenPool
10
                  if (token \in TokenPool(p_i))
                    if (originator failed)
11
12
                        ProcessToken
13
                     end
14
                  else /* token not in TokenPool */
15
                    if (received for the first time)
                        ProcessToken
16
17
                     end
18
                 end
19
              end
20
          else /* a token was received */
21
             if (received for the first time)
                 ProcessToken
22
23
            end
24
          end
25
       end
26 end
```

Figure 11 Agreement Processor

1. Initiate_Agreement Message

When AgreeProcessor receives an initiate_agreement message, the appropriate agree token is generated, added to the token pool and forwarded to the cwnbr. The

status table entry for the subject is updated. An acknowledgment is returned to the calling process. This reflects no change to the prior specification.

2. External Token Pool

When an external token pool is received, it is compared to the local token pool. All tokens in the external token pool are examined. Processing of a token depends on whether the token is also present in the local token pool.

If an *agree* token from the external token pool is in the local token pool, the token originator may have failed. Due to a failure of the originator, the *agree* token is requires conversion into a *commit* token at the first active clockwise neighbor of the originator only. Such tokens are processed as if they had been received as a separate token message. If the token is not present, it may have already been purged. These tokens must be rejected as duplicates.

a. Token Originator Failed

Detection of the token originator failing prior to initiating the *commit* phase is accomplished separately for *joinagree* and *failagree* tokens. Figure 12. It is necessary for the next active member to detect the originator's failure and also initiate the *commit* phase for the incomplete change started by the originator. The *agree* token may be received as part of the external token pool. The token will also be present in the local token pool from the *acwnbr* of the failed originator. This situation may also occur if a member in the middle of the ring fails. The failed member's *cwnbr* will receive an external token pool containing the original *agree*. However, this does not require a *commit* to be initiated as the originator has not failed. It is essential that the differences be noted and accounted for. The same conditions are present, but different processing must occur.

The originator's failure during a *joinagree* phase can be detected if the rank of the external token pool originator is greater than the rank of the current member. Consider the host failing prior to initiating the *commit* phase. All members in the group have agreed to the *join*. The *joinagree* token will be received by the new host upon ring reconfiguration. The new host's rank is zero (0) while the external token pool originator's

rank is the (group size - 1). Since **Rank**(originator) > **Rank**(host), a **commit** must be initiated.

Consider member p_i with rank i failing during the **joinagree** phase. When the failure of p_i is detected, p_{i+1} receives the external token pool from p_{i-1} . The **joinagree** token is present in both the external token pool and $TokenPool(p_{i+1})$. The token is rejected since $Rank(p_{i+1}) < Rank(p_{i+1})$,.

```
LostAgreeToken
1 if (joinagree)
2
      if (rank(p) > rank(p))
3
        return true
4
5
        return false
6
      end
7 end
8
   if (failagree)
      if (RelativeRank(p_i, p_i) > RelativeRank(p_i, p_i))
10
         return true
11
      else
12
         return false
13
      end
14 end
```

Figure 12 Determination of Token Originator's Failure

Now we consider a duplicate *failagree* token. Define *RelativeRank*(p_j , p_i) as the rank of p_j with respect to p_i instead of the host. A ring transversal starts and ends at the same specified process, i.e. any given member follows itself in a ring transversal. Figure 13. *RelativeRank* for a process that is not a member of the group is undefined. Recall the subject of a *failagree* remains a member of the group view until the *commit* is processed. A lost *failagree* token is determined by the *RelativeRank* of the token subject p_i and token pool originator p_{ino} .

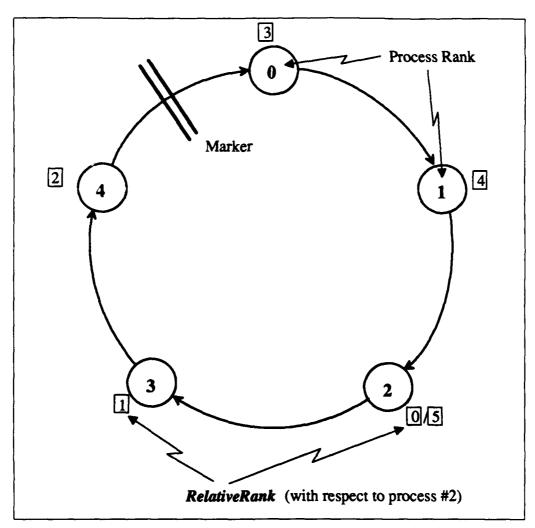


Figure 13 Relative Rank

If the $RelativeRank(p_i, p_i) \ge RelativeRank(p_{ipo}, p_i)$ the token originator has failed and the *failcomit* phase should be initiated. This situation will occur if the failed token originator itself fails prior to initiating the *commit* phase.

b. Duplicate Processing

Conditions to detect if a token has been received and processed already are summarized in Table 1. It is necessary to detect duplicate processing if the external token pool contains tokens not found in the local token pool. There are two possible ways for this to occur. If the token has not been received and processed, or the token has been purged from the local token pool.

Table 1 CONDITIONS TO DETECT DUPLICATE PROCESSING

Token	Condition
joinreqst joinagree joincomit	$p_k \in GV_{p_i}$
failagree failcomit	$p_k \notin GV_{p_i}$

Consider the *commit* phase. All members of the group have agreed to a particular ring reconfiguration. Due to the latency of token transmission around the ring, not all members commit the change simultaneously. Recall the token pool is purged of old *commit* tokens and the corresponding *agree* token prior to the *commit* token transmission. If a member that has committed a change receives an external token pool from a member that has agreed to the change, the *agree* token remains in the external token pool. Likewise, a previous *commit* token may be received as part of the external token pool. Since the tokens have been processed and removed from the local token pool, it is necessary to check the effects these tokens may have had on the group view, had they been previously processed. For duplicate *join* tokens, the subject would already be a part of the group view. Conversely, the subject of duplicate *fail* tokens would have already been removed from the group view. In this manner, duplicate processing can be detected and the tokens rejected.

It is not necessary to include all possible conditions for a token having been processed. Recall the duplicate processing check occurs only if the token is not present in the local token pool. For a *joinreqst*, if the token is received as part of the external token pool and has been purged from the local token pool, the *joincomit* must have occurred. Since the result of the *joincomit* is subject becoming a part of the group, it is only necessary to check the end result. Intermediate stages of the *join* process have not deleted the *joinreqs*t token from the local token pool. Since the token remains in the

token pool, it is in both local and external token pools and is rejected. Similar logic results in the conditions presented in Table 1.

3. Tokens

Each type of token is handled individually upon receipt by AgreeProcessor. Figure 14. AgreeProcessor acts as a filter to remove duplicate tokens before forwarding non-agree tokens to the appropriate processor. Agree tokens are processed locally.

a. Joinregst Tokens

The *joinreqst* tokens are forwarded to *JoinProcessor* for further processing.

b. Agree Tokens

If the current process is not the originator of the token, and it is not part of the local token pool, it is added to the token pool, the status updated and the token sent to the *cwnbr*. This accounts for the first time an *agree* token is received and processed.

```
ProcessToken
1 if (joinregst)
           send token to JoinProcessor
3
    elseif (commit)
4
         send token to ComitProcessor
5
    elseif (agree)
         if ((p_i \neq p_i) \&\& (agree \text{ token } \notin TokenPool(p_i))
6
             add agree<sub>pi</sub>(p<sub>k</sub>) to TokenPool(p<sub>i</sub>)
7
8
             ST_{p}(p_{k}) \leftarrow FailAgreed or JoinAgreed
9
             send agree_{p_i}(p_k) to cwnbr(p_i)
10
          else
11
             if ((p_i = p_i) \parallel (\forall p_i \mid p_i \rightarrow p_i, p_i \in ST_{p_i}))
                 compute rank \forall p_i \in ST_{p_i} with Agreed status
12
13
                 if rank(p_{\bullet}) = smallest
                    send initiate_comit to ComitProcessor
14
15
                  else
                      ST_{p}(p_{b}) \leftarrow joinpendg \text{ or } failpendg
16
17
                 end
18
             end
19
          end
20 end
```

Figure 14 Processing Agree Tokens

If the current process is the token originator, or the first active process clockwise from the originator that receives the *agree* token after it circulates around the ring, the rank of all processes with an *agreed* status is computed. An *initiate_commit* is transmitted if the subject is the lowest ranked of all processes fulfilling the above conditions. If not, the subject's status is updated to *pending*.

c. Commit Tokens

A commit token is immediately sent to CommitProcessor for processing.

4. Side Effects

The external token pool mentioned above requires a new message type, ExTknPool. Figure 15. The message includes the originator of the token pool as an internal field. This is required by AgreeProcessor for determination of a failed token originator.

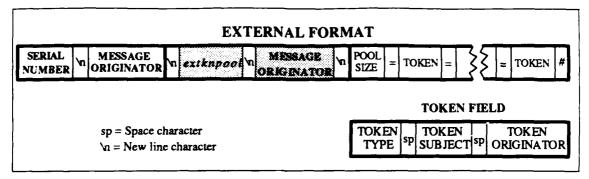


Figure 15 External Token Pool Message Format

F. MULTIPLE JOINS

1. Problem

Consider two members attempting to join a group almost simultaneously. Figures 16-18. The first member's join will be completed properly. Upon completion of the first join, it is possible to begin processing the second member's joinreqst before the FIFO channels reflect the re-configured ring with the first member in it. It is possible to complete the second *join* before the channels are re-configured. This can happen because of the de-coupled protocol and FIFO channels. The host does not change its acwnbr until it initiates a status query to the last member. The FIFO channel determines a member's acwnbr as the target of the most recent status ary. The cwnbr is the originator of the most recent status gry received. There is an inherent latency involved in the FIFO channel reconfiguration due to the timing considerations of subsequent statusqrys. Thus, it is possible for a joinregst from a second new member to complete both phases of the join process prior to FIFO channel reconfiguration. The first new member may never have processed the joinagree and joincomit for the second joining member prior to the second member being incorporated into the group view. When the first joining member determines its acwnbr and receives the external token pool, the joincomit token for the second member may be present. Processing the token will result in attempts to delete the corresponding nonexistent joinagree token never received by the first member and subsequent removal of the second member from the status table. Both of these are error conditions.

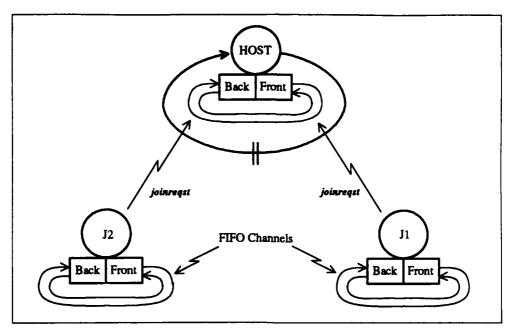


Figure 16 Simultaneous Joins

2. Solution

Initiate the FIFO reconfiguration upon transmission of the initial parameters to the new member. Figure 10, line 7.

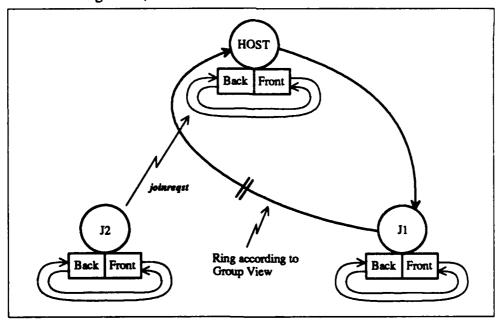


Figure 17 Group View after 1 member has joined

3. Justification

The FIFO channel can be considered to be re-configured when the host determines its acwnbr. The response from the new acwnbr is not required, as the FIFO channel reject all tokens unless they are sent by the acwnbr. Tokens from the old acwnbr are rejected and must be processed by the new acwnbr prior to being forwarded to the host member.

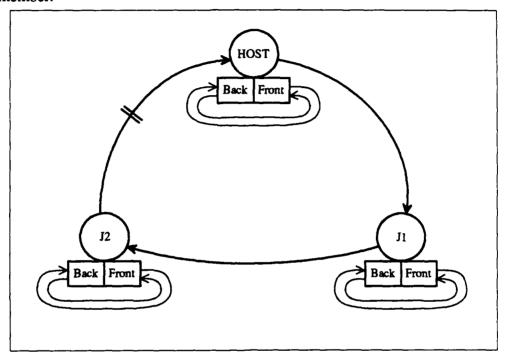


Figure 18 Group View at Host & J2

G. OTHER IMPROVEMENTS

In this section, oversights to the protocol specification and the modifications required are briefly described.

1. Joinregst Token Processing

a. Problem

When processing a join message from a prospective member, *InitiateJoin* adds a *joinreqst* token to the token pool prior to generating it.

b. Solution

If the current message being processed is a join message, generate the **joinreqst** token and then add the token to the token pool. Figure 19, lines 10-13.

```
InitiateJoin for a join request message/token for p<sub>acc</sub> at p<sub>i</sub>
1 while (true)
       if (p_{new} \notin ST_{p_i}, GV_{p_i})
          receive join request message or token for p___
4
       end
5
        if (p_i = p_{host})
6
          send initiate agreement message to AgreeProcessor for p
          block until AgreeProcessor acknowledges end of processing
8
        else
9
            ST_{Pi}(p_{new}) \leftarrow Joi: Requested
           if (join request message) /* p<sub>new</sub> locates p<sub>i</sub> and sends its join request */
10
11
              generate joinreq<sub>Pi</sub>(P<sub>now</sub>) token
12
            add joinreq<sub>Pi</sub>(p<sub>new</sub>) to TokenPool(p<sub>i</sub>)
13
           send joinreq token to cwnbr(p,)
14
15
16 end
```

Figure 19 Processing of a Join Request Message / Token

2. Commit Token Generation

a. Problem

If a member was in a *pending* status, a commit token for that process was never generated prior to committing the change. These members would remain *pending* indefinitely.

b. Solution

Create the commit token before committing the change for a member with a pending status. Figure 20, lines 11-12.

```
ProcessCommitTkn for commit<sub>Pi</sub>(p_k) at p_i
   if (initiate commit message received)
      generate commit token
      token to be processed ← generated token
   else if ((p_i \neq p_i) \&\& (not duplicate))
      token to be processed ← received token
6
    else
      exit
   end
9 CommitChange
10 while (p_i \in ST_{p_i}) with pending status & Rank(p_i) < Rank(p_m), p_m \in ST_{p_i}
11
      generate commit token
      token to be processed \leftarrow generated token
12
13
      CommitChange in rank order
14 end
```

Figure 20 Generate / Receive and Process a Commit Token

3. Message Queue in the FIFO Channel Layer

The front processor was modified to transmit the head of the message queue after receiving any message, either on the internal or external channel. Figure 21.

```
FIFO Channel - FRONT Process
1 Wait for a channel ready to read
2 if (external channel ready)
3
     if (Status Query)
4
        send Status Query to MonitorProcess
5
     else if (JoinRequest)
        send JoinRequest to JoinProcessor
6
7
     else if (InitialParameters)
        send InitialParameters to JoinProcessor
8
9
     else if (TokenAck)
        if (Received Serial Number = Expected serial number)
10
           remove Head of Queue
11
          decrement Queue_Counter
12
13
        end
     end
15 else /* internal channel ready */
16
      if (Token)
17
         change Token to external format /* add external header */
         insert Token in queue
18
         increment Serial Number
19
20
         increment Queue Counter
21
      else if (TokenPool)
22
         discard all messages in queue
23
         change TokenPool to external format /* add external header */
24
         insert TokenPool in queue
25
         increment Serial Number
26
         increment Queue Counter
27
      else if (StatusReport)
28
          update cwnbr
29
          send StatusReport to cwnbr
30
       end
31 end
32 if (Queue_Counter > 0)
33
       send Head of Queue to cwnbr
       set Expected serial_number = Head_of_Queue_serial_number
34
35 end
```

Figure 21 FIFO Channel - Front Process

H. SYNOPSIS

This chapter has described the changes that were required to successfully implement the group membership protocol. Changes covered coding as well as protocol related problems not discovered in the original specification. These changes deal with the correct functioning of the protocol and do not address performance issues. Performance is dealt with in Chapter IV.

IV. PERFORMANCE OF THE GMP

The performance of the protocol on the Electrical and Computer Engineering Local Area Network (ECE LAN) consisting of SUN2 workstations connected via an Ethernet, was measured and the results are presented in this chapter.

A. LATENCY

The latency involved in processing changes to the group view is measured by each member using the local time clock on each specific processor. Timestamps were generated for the conditions listed in Table 2.

Table 2 CONDITIONS WARRANTING A TIME STAMP

Time Stamp	Where Taken in Code
t _{ai}	initiate an agree token
t _æ	receive an agree token
t _{cs}	send a commit token

The timestamps and related data were dumped to a file local to each processor. A filter program was designed and written to compile the data from the various systems, given a list of the members in the test group, and the maximum number of members. The filter program was designed for a restricted set of all possible group views given the above data. The case when the group view starts as the initial member, grows to the maximum number of members and then shrinks to the original host is the only possible case handled by the filter. Figure 22 illustrates the required group view changes.

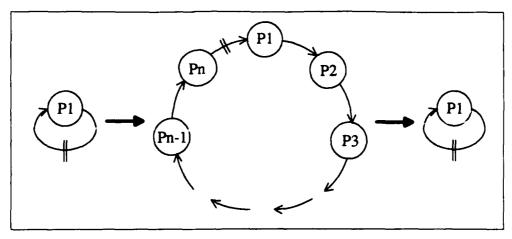


Figure 22 Group Changes Required by the Filter Program

A further restriction is that all members departing the group must be the host's acwnbr. This removes the need for a local database in the filter program to track which members are part of the current iteration of timestamp evaluations. Future improvements to the filter program can implement a dynamic database to account for all possible changes to the test group. The format of the output file is shown in Figure 23.

agree	sp	sec	sp	usec	init	j				
agree	sp	sec	sp	usec	recv	change to group size	sp	subject	sp	originator
comit	sp	sec	sp	usec	send]	sp =	space		

Figure 23 Time Stamp File Format

The time required to implement a change at a given member i is calculated by subtracting the initial time stamp from the completion time stamp.

$$t_i = t_{cs} - t_{ar} \mid i \neq host$$

 $t_i = t_{cs} - t_{ai} \mid i = host$

The average time to commit a change at each member was calculated as follows:

$$\bar{t} = \frac{\sum_{i=1}^{n} t_i}{n}.$$

However, as the group increases from n members to n+1 members, the *joinagree* must be processed by the n members currently in the group. Similarly, the n members

must receive and process the **joincomit** token. Hence, for a join to a group of n members, the processing time must be $n(t_{agree} + t_{comit})$, where t_{agree} is the time required to process an **agree** token and t_{comit} is the time to process a **commit** token. The communication time to transmit the token from one member to its neighbor is t_{comm} . Since each of the tokens must be transmitted to the n members, the total communication cost is $t = 2n * (t_{comm})$. Therefore, the total time required to implement a **join** at all members of a n member group is

$$t = n(t_{agree} + t_{commit} + 2t_{comm})$$

Notice that the time to implement a change is proportional to the size of the group.

Table 4 PROCESSING TIME VALUES

Time	Occurrence
tagree	time to process an agree token
t _{commit}	time to process a commit token
t _{comm}	inter-member communication time

Similarly, the expected time for a failure can be determined to have a linear relationship to the size of the remaining group.

B. TESTING

The performance of the GMP was tested on the ECE LAN consisting of SUN workstations linked via an Ethernet. There were no gateways between any of the members of the group. Only single complete changes were allowed at any given time. A complete reconfiguration included the underlying FIFO channel as well as the logical ring structure. A linear relationship was observed between the number of members in the group and the average time it took to commit the new member. Figure 24. Since the communication depends heavily upon the network load as well as the individual processor load, average values over a large variety of conditions such as time of day and number of people on the network were generated in order to get reliable data points.

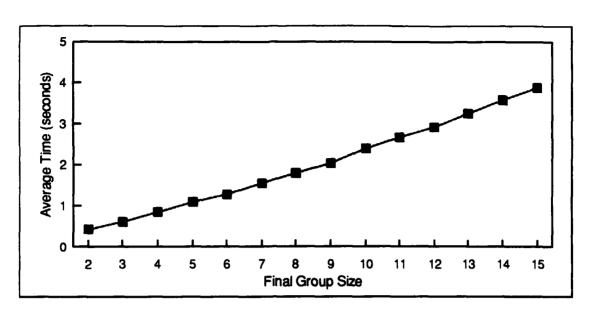


Figure 24 Average Time for each Member to Implement a Join to the Group

Similarly, the time required to remove a member from the group view was obtained and plotted. Thus, the relationship between time and group size was determined for a decreasing group size. Again, only single complete changes were allowed. Figure 25. A linear relationship was observed as expected.

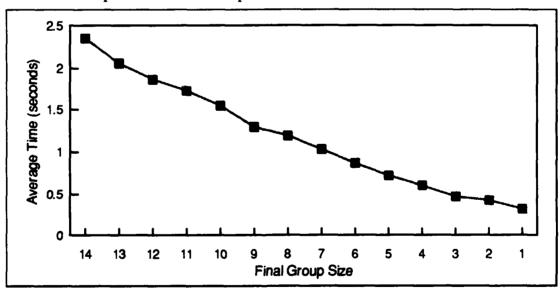


Figure 25 Average Time to Implement a Failure in the Group

V. METHODS FOR IMPROVING PERFORMANCE

In this chapter we explore two methods that might be used to further improve the overall performance of the protocol. Each could be incorporated along with the other or individually.

A. MESSAGE REDUCTION

The protocol as currently implemented has a high overhead due to the number of inter-member messages required to effect changes in the logical ring structure. In order to reduce the number of messages required for the maintenance of the logical ring, structure three methods are discussed below.

1. TokenPool versus Tokens

Consider multiple near simultaneous changes to the group view. Transmitting the token pool instead of individual tokens will result in a reduction of messages if the changes occur close enough together such that the token pool for one change includes the tokens for the subsequent changes. This will result in a decreased number of messages. However, the probability of such changes occurring is minimal. Since changes to the group are uncorrelated, the probability of such changes occurring is minimal. The corresponding reduction of message traffic is negligible. Additionally, there is an increase in the size of the message for most traffic. Modifications required to effect this include the dynamic generation of the group view by the FIFO channel. Instead of receiving the token pool for generation, the FIFO channel would receive a flag and, at that point, generate the external token pool message. One such method might be to set a flag that indicates that the token pool must be transmitted. FIFO properties are maintained by the order in which the tokens are processed upon receipt. Reduction will occur only if multiple changes occur prior to the transmission of the token pool for the initial change. Problems arise in the correct setting of the transmit flag; i.e., did change #2 get sent in the last token pool,

or is another token pool transmit required. This method is not recommended since the number of messages is reduced only in special cases.

2. Periodic Token Pool

Recall that tokens are generated only if a change to the group view occurs. Another method that will reduce the number of inter-member messages is to periodically send the token pool instead of individual tokens. In this manner, multiple tokens can be transmitted simultaneously. Message reduction is indicated only if multiple changes to the group view occur within the period of the token pool transmission. If this does not occur, message traffic will actually increase; i.e., if there are no changes within this period the token pool is still transmitted. This method will also increase the latency in phase completion as tokens are not immediately forwarded around the ring. Additionally, the message size will be increased. This method is not recommended either.

3. Piggyback the Token Pool

A further refinement would be to include the local token pool as part of the status report. The monitoring member, upon receipt of a *statusrpt*, would parse the token pool and process the appropriate tokens. FIFO channel requirements are maintained by the order in which tokens are processed upon receipt of a token pool. This, however, leads to additional processing for every status report.

Difficulties might occur in the latency of cycle completion in a large group. Most notably, consider when a new member has requested to join an existing group. Define t_i as the latency within a process. It is the difference in time between receiving the token pool via a **statusrpt** and transmitting the tokens around the ring. t_i can be modeled as a random variable. Ignoring the communication time, t_{comm} , and the processing time, t_{proc} , associated with the normal processing of tokens, the latency for a change to an N member group (i.e. a join request) becomes:

$$T_{total} = 2(N \times t_l)$$

Thus, the latency involved may become prohibitive for large N. This method is recommended for implementation, provided that the latency of changes is not important.

Care must be taken to ensure the time-out on a join request is large enough to encompass the worst case scenario. However, since the time-out is finite, this method place an implicit upper bound on the maximum group size. Once the group is large enough, new members will be unable to join due to the time needed to implement the *join* around the ring.

B. SINGLE-THREADED PROGRAM

1. Problem

The current design of the protocol involves concurrent processes handling specific areas of responsibility. Fully implementing this design would allow each process to reside on different processors. However, in most cases, a single processor is the norm. There is a significant amount of overhead due to the context switching and intra-member messages. The asynchronous nature of the protocol has several areas requiring process blocking as mentioned in chapter III.

2. Solution

Redesign the main process using a single-threaded program. Figure 26 shows the recommended processes and inter-dependencies.

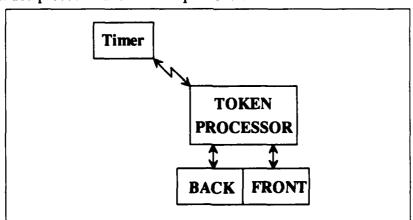


Figure 26 Single-Threaded Process Inter-Dependencies

3. Justification

The *TokenProcessor* would be a single-threaded program combining all aspects of the current design as shown in Table 4. The watchdog timer must still be a separate

entity by definition. The FIFO channel is not included in the *TokenProcessor* as *Back* and *Front*, are by nature, separate programs without any timing restrictions.

Table 4 SINGLE THREADED PROCESSES AND EQUIVALENTS

Single-Threaded GMP	Multi-Threaded GMP
Timer	Timer
	JoinProcessor
	AgreeProcessor
	ComitProcessor
	IntegrateMember
TokenProcessor	
	Status Table Manager
	Group View Manager
	Token Pool Manager
	StatusMonitor
	StatusReporter
BACK	BACK
FRONT	FRONT

The asynchronous nature of the design would be eliminated. The need for block and wait would be eliminated if a single-threaded program design were to be used. Additionally, the design would result in a significant decrease in the overhead costs due to the inter-process messages and connecting services being eliminated. The single-threaded program also eliminates the need for separate database managers. The TokenProcessor can maintain all databases internally, with different pointers keeping the different databases separate.

Concurrent with the new design, a review of all subroutines is recommended. Current design and programming practices preserves all data passed to the subroutines. This can lead to significant overhead since the data is stored multiple times.

VI. CONCLUSIONS AND RECOMMENDATIONS

In this thesis, the modifications required to implement the group membership protocol as proposed by [5] are presented. The protocol has been successfully implemented and to date has run continuously for more than 48 hours with a stable group membership. Additionally, a group size of 20 members was achieved. These results, though preliminary, are the first for this protocol. Although the protocol is functioning, continued debugging and improvement are currently going on.

As expected, the time required to implement a change was found to have a linear relationship to the eventual group size.

Further work should include the re-design of the protocol as a single-threaded program. In this manner, the response of the protocol can be improved as inter-process communication time is reduced drastically. However, attempting to implement the message reduction schemes to improve performance is not recommended as there is little to gain in the number of messages. On the contrary, implementation of the message reduction schemes would result in a large increase in the latency of changes to the membership.

Additional research is suggested in the area of network partitioning. Consider that a network may partition in two separate halves that are fully connected on either side of the boundary. A group originally existing on both sides will become two groups with the same name operating independently on either side of the partition. The difficulty arises when the network is repaired. The protocol does not provide for the possibility of merging the two groups back into the original group. The problem of handling network partitioning is non-trivial.

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APPENDIX

The following code is included for completeness.

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Definitions & Utilities
Simple Application & Main Process
FIFO Channel Processes
Monitor Processes
Agree Processor
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#endif /* INADDR_NONE */ #define INADDR_NONE #ifindef INADDR_NONE #define HEADERSIZE #define ITMERMSG #define REALI OC(ptr.n.type) (type *)realloc(ptr.(unsigned) (n*sizeof(type))) #define CALLOC(n,type) (type *)calloc((unsigned) n,sizeof(type)) * Definitions for GMP programs finclude <sys/socket.h> Metine FRONT_PORT finclude cretines/m.h> Finclude <sys/types.h> finclude <sysfactlh> finclude <sys/uio.h> finclude <sys/unb> finclude <signal h> finclude anadaho finclude <string.h> Firchde Asclibity finchate cermohy finclude cardio by

Continue

2 =

"131.120.20.102" /* host address for server sun2 */ "/mp/so.XXXXXXX" "/s.unixstr" Adeline SERV HOST ADDR Modefine UNIXSTR_PATH MOSTINE UNIXSTR_TIMPL Moderne BACK PORT Hefine MAXPATH **#define MAXPORT** Moderne MAXI.INE Mefine MAXFD Mefine FALSE Adding TRUE

The following definitions do not account for the terminating NULL */

MODELING MAXIMOSTNAME 50

Mefine MAXNUM

Mdefine MAXI_MTSIZE

Moderne MAXIF. AME

Mefine NODATAMSG

Adefine BUFSIZE

MAXIPNAME + 2*MAXPORT + 2

13 453735 *define TOKENTOKN Actine TOKENACKN Holefine INVALDMSG #define TOKENPOOL Adefine DELTTOKEN HAPLING CROUPVIEW #define STATUSQRY **define STATUSRPT ** Hefine UPDSTATUS **#define UPDATVIEW #define TOKPRECST** *define EXTKNPOOL Holefine INTIPARAM **#tlefine VIEWREOST Adefine STATREOST** Hofune STARTTIMR Holefine STATUSTBL Adefine JOINREOST Ktefine INITIOKEN Ktefine SNDINIPAR *thefine INITGVIEW Adefine INTITABLE *define TIMEOUT_ define INITIPOOL

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```
/initialize pointer/
                                                                                                                      'qupir' must be created before the first call to
                                                                                                                                                                                                                  /declaration/
                                                                                                                                                                                                                                                                          qu.tail = qu.head = NULL; / empty queue /
                                                                                         The original 'msg' is not modified.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ptrimnt->data =: CALLOC(strien(msg) + 1, char);
                                enqueue - inserts the external message 'msg' at the
                                                                                                                                                                                                                                                                                                                                       enqueue(quptr, msg); / function call /
                                                                                                                                                       enqueue(). To create a queue use:
                                                               tail of the queue 'quptr'.
                                                                                                                                                                                                                                             queue *quptr = &qu;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ptrimnt = CALLOC(1, link);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             strcpy(ptrlmnt->data, msg);
                                                                                                                                                                                                                                                                                                                                                                                                   void enqueue(head, tail, msg)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     *purlmnt, *ump;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          parlmut-ynext = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      tmp->next = ptrlmnt;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (*head = NULL)
                                                                                                                                                                                                                   queue qu;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  *head = purlmnt;
                                                                                                                                                                                                                                                                                                                                                                                                                            link **head, **tail;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             *tail = ptrlmnt;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               *tail = ptrlmnt;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ump = "tail;
                                                                                                                                                                                                                                                                                                                                                                                                                                                            char *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        eke
****************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * QUEUE HANDLING AUXILLARY FUNCTIONS FOR FIFO PROCESSES
                                                                                                                                                                                                                                                                                                                                                                                                                            Refer to the function header comments for detailed info.
                                                                                                                                                                                                                                                                                                                                                                                                                                                            Some functions in this file need socurilic and msgutilic
                                                                                                                                                                                                                                                                            void send_ack(char *msg, char *orig, char *dest);
                                                                                                                                                                                                              woid get_queue_head(queue *quptr, char **msg);
                                                                                                                        The following functions are available to be used:
                                                                                                                                                                                                                                                                                                        void send_msg_back(char *msg, char *dest);
                                                                                                                                                                                                                                                                                                                                     void send_msg_from(char *msg, char *dest);
void send_msg_in(char *msg, char *dest);
                                                                                                                                                       void enqueue(queue *quptr, char *msg)
                                                                                                                                                                                                                                               void flush_queue(queue *quptr);
                                                                                                                                                                                    void dequeue (queue *quptr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Fernando J. Pires
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                David Pezdintz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           12 Jul 1993
```

Last revision:

* Writen by:

(FIFOUTIL.C)

} /* and enqueue */

```
void get_queue_head(head, msg)
                                                                                                                                                                                                                                                                          } /* end get_queue_head */
                                                                                                                                                                                                                                                    *msg = head->data; }
                                                                                                                                                                                              if (head = NULL)(
                                                                                                                                                                                                               *msg = NULL; }
                                                                                                                                                       char **msg;
                                                                                                                                    link *head;
dequeue - remove a msg from the head of the queue 'quptr'.
                                                           Sample call: dequeue(quptr);
                                                                                                                                                                                                                                                                                           if (head == NULL){
*tail = NULL; }
                                                                                                **************
                                                                                                                   void dequeue(head, tail)
                                                                                                                                                                                                                                                        *head = ump->next;
                                                                                                                                                                                                              if (*head!= NULL) {
                                                                                                                                                                                                                                                                                                                                                                        free(mp);
} /* end if quptr */
                                                                                                                                                                                                                                                                                                                                                                                                                                /* end dequeue */
                                                                                                                                                                                                                                                                                                                                                     free(trnp->data);
                                                                                                                                     link **head, **tail;
                                                                                                                                                                                                                                   tmp = *head;
                                                                                                                                                                         link "tenp:
```

```
get_queue_head - returns a pointer to the message at the head of the queue.
                                                                                        Sample call: get_queue_head(quptr, &msg);
```

```
*************************
                          hush queue - remove all nodes of 'quptr' from memory.
                                                                           qupt' remains a valid empty queue and can be
                                                      All used memory is deallocated.
                                                                                                                                                         void flush_queue(head, tail)
                                                                                                                                **************
                                                                                                                                                                                                                                                                                     while (*head!= NULL) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               / card flush_queue */
                                                                                                                                                                                                                                                                                                                                       *head = tmp->next;
                                                                                                       reused by enqueue().
                                                                                                                                                                                                                                                                                                                                                                                          free(ump->data);
                                                                                                                                                                                  link **head, **tail;
                                                                                                                                                                                                                                                                                                              ump = "head;
                                                                                                                                                                                                                                     A T
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            *Bail = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                 free(ump);
```

```
specified IP destination 'dest'. 'dest' is a string with element address format.
                                 send_msg_front - sends an external message imsg' to the front port of the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             printf("sen_msg_front: IP address errorvn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                printf("sen_msg_front front port error\n");
                                                                                                                                                    Sample call: send_msg_front(msg, dest);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ump = CALLOC(strlen(dest) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (getfromlist(list, & frontport, 2) != 2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      senmsg(msg, strlen(msg), IPaddr, port);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              port = hions( (u_short)atoi(frontport) );
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (getfromlist(list, & IPaddr, 1)!= 1) {
                                                                                           The original message is not disturbed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* convert port # to network format */
                                                                                                                                                                                                                                                                                                                                                        *Paddr, *frontport, *tmp;
                                                                                                                                                                                                                                                                                                                                                                                                                                               /* make a copy of the address */
                                                                                                                                                                                                                                       void send_msg_front(msg, dest)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } /* end send_msg_front */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                list = str2list(tmp, ";");
                                                                                                                                                                                                                                                                     *msg, *dest;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(unp,dest);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               removelist(list);
                                                                                                                                                                                                                                                                                                                              *fisi
                                                                                                                                                                                                                                                                                                                                                                                        u_short port;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           free(tmp);
                                                                                                                                                                                                                                                                                                                                                            char
                                                                                                                                                                                                                                                                                                                               ii,
```

```
************************
                                send_ack - assembles an ack as a reponse to an external
                                                                                          fron port of the specified IP destination 'dest'
                                                                                                                        'dest' is a string with element address format.
                                                                                                                                                       The original message is not disturbed.
                                                                                                                                                                                                             Sample call: send_ack(msg, dest);
                                                               mes age imsg' and sends it to the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            free(ackmsg);
                                                                                                                                                                                                                                                                                                                                                                                              Ä
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                          Char
                                                                                                                                                                                                                                                                                                                                                                                              直
 send_msg_back - sends an external message 'msg' to the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("send_msg_back: IP address error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           printf("send_msg_back: back port errorhn");
                                                           back port of the specified IP destination 'dest'
                                                                                      dest is a string with element address format.
                                                                                                                                                                                Sample call: send_msg_back(msg, dest);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (getfromlist(list, &backport, 3) != 3) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      senmsg(msg, strlen(msg), IPaddr, port);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     port = htorns((u_short)atoi(backport));
                                                                                                                      The original message is not disturbed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if ( getfromlist(list, & Paddr, 1) !=1) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ump = CALLOC(strien(dext)+1,char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* convert port # to network format */
                                                                                                                                                                                                                                                                                                                                                                                      *IPaddr, *backport, *tmp;
                                                                                                                                                                                                                                          ******
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* make a copy of the address */
                                                                                                                                                                                                                                                                     void send_msg_back(msg, dest)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    list = str2list(tmp, ";");
                                                                                                                                                                                                                                                                                                     *msg, *dest;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strcpy(tmp, dest);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                removehist(list);
                                                                                                                                                                                                                                                                                                                                                             , N
                                                                                                                                                                                                                                                                                                                                                                                                                         u short port;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exis(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cxif(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            free(tring);
```

/* and send msg back */

```
ackrnsg = REALLOC(ackrnsg, strlen(ackrnsg) + strlen(orig) + 13, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("send_ack: serial number in errorn");
                                                                                                                                                                                                                               imp = CALLOC(strien(msg) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                           if (getfromlist(list, &ackmsg, 1) != 1) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              streat(ackmsg, "vitokenackm#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       send_msg_front(ackmsg, dest);
                                                                                                                                                                                                        /* make a copy of the msg */
                            void send_ack(msg, orig, dest)
                                                                                                                                                                                                                                                                                                                      /* assemble ack message */
                                                        *msg, *orig, *dest;
                                                                                                                                            *ackmsg. *mp;
                                                                                                                                                                                                                                                                                                                                                  list = str2list(tmp, "\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   streat(acloring,"\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strcat(ackmsg,orig);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* end send_ack */
                                                                                                                                                                                                                                                                 strcpy(tmp,msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          free(trmp);
```

```
send_msg_in - sends an external message imsg' to the
                                                                                 The message is converted to internal format, before
                                                                                                               transmission. The original message string is not
                          the specified unix socket destination 'dest'
                                                                                                                                                                                                      Sample call: send_msg_in(msg, dest);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* open and connect socket to server */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (getfromlist(list, &theader, 3) != 3) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       tmp = CALLOC(msglen + 1, char);
                                                      dest' is a string with a path name.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* make a copy of the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                        *header, *mp, *inmsg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             printf("sen_msg_in: error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                immsg = msg + (header - tmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* discard external header */
                                                                                                                                                                                                                                                            void send_msg_in(msg, dest)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     sockfd = connectUN(dest);
                                                                                                                                                                                                                                                                                                                                                                                                          msglen, sockfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        list = str2list(tmp, "\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             msglen = strlen(msg);
                                                                                                                                                                                                                                                                                         *msg, *dest;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     strcpy(unp, msg);
                                                                                                                                                                                                                                                                                                                                                                                 ā
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                             disturbed.
```

/* send msg to socket */
msglen = strlen(iransg);

removelist(list); free(mp); close(sockfd); /* end send_msg_in */

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#define COUNT_DOWN_STEP 1000 /* 1 timer tick is AT LEAST 1000 micro seconds. */ MSGTYPELEN+MAXLMTSIZE+STSTYPELEN+3 MSGTYPELEN+2*MAXNUM+MAXLMTSIZE+4 /* 3rd field is the first element in token pool list */ 10000 /* resent request after at least 10 seconds. */ 2*MAXLMTSIZE+TOKENTYPELEN+3 2*MSGTYPELEN+2+MAXLMTSIZE+1 MSGTYPELEN+2*MAXLMTSIZE+3 TOKENI EN+MSGTYPEL EN+2 /* The following definitions do not account for the terminating NULL */ 14+MAXLMTSIZE+1 10+MAXLMTSIZE+1 ICTOKEN ENTI 250 /* 25 sec */ 500 /* 5 sec */ m *define INITTOKENIMSGLEN **#define TPAD INTERVAL** #define TQRY_INTERVAL #define UPDTSTSMSGLEN #define TKPLISTOFFSET #define TOKENTYPELEN Adefine INITIGNAISGLEN MAGINE TOKENMISGLEN #define RESENDREOST #define UPDTVIEWLEN #define MSGTYPELEN #define STSTYPELEN HACE DELIKALEN #defi SNDINIPLEN #define TOKENLEN #define OUERYLEN /* 4th field is the first element in gv list */ /* 3rd field is the first element in st list */ Utilities for the protocol processes. (graputil.c) GetMembWithRank(); * Written by: Shridhar Shukla David Pezdirtz Description: GetAcwnbr(): GetGroupView(); GetStatusTable(); GerTokenType(); TokensREqual(); GetTokenPool(); GetGroupSize(); InStatusTable(): SendThn2Agr(): RelativeRank(); Mefine NONBLOCKING inTokenPool(): 23 Nov 1993 Mdefine GVLLSTOFFSET CountDown(): Mefine STLLISTOFFSET agreetoken(); comittoken(); GetStatus(); GetRank(); first time(); Mefine BLOCKING InGroup(): Mefine JOINAGREE Mefine FAIL AGREE Hefine FAILCOMIT Mefine JOINCOMIT #define JOINRQSTT * Date

finclude <sys/time.h> Finchote <sys/filioh> Finchude "magnitile" finchate "socutile." finclude <time.h> Firchide "gmp.h"

int GetAcumbr();

int InStatus Table();

int InTokenPool();

nt GetMembWithRank();

nt TokensREqual();

nt InGroup();

nt CountDown();

int GetRank();

nt GerTokenType();

int GerGroupSize();

void SendTKn2Agr();

int GerStatus();

int RelativeRank();

char *GetGroupView();

char *GetStatusTable();

char *GetTokenPool();

int agrectoken();

int committeden();

int first_time();

address as computed from the current group view, obtained from the group view manager at gymsoc and the current status table obtained from strnsoc according to the rule in the paper. In all GetAcwnbr: returns 0 if acwnbr is correctly initialized to a member other cases, returns -1.

The group view must contain at least one element - the member It is assumed that myaddr is never in st. This function does not table must at least contain the number of elements, even if 0. itself. The first element is always the ring host. The status check for myaddr being part of st.

int GetAcwnbr(acwnbr, myaddr, stmsoc, gvmsoc) char *acwnbr, *myaddr, *stmsoc, *gvmsoc;

*gybuf, *stbuf, request[NODATAMSG+1], *candidate, *nextmember, msglen, stmfd, gvmfd, gvsize, stsize, stmsglen, myrank, candidateposition, found, search complete, myposition; gvsizestmg, *stsizestmg,

gvmfd = connectUN(gvmsoc); strcpy(request, "viewreqs#"); msglen = strlen(request); /*acquire group view */

if (writemsg(gvmfd, request, msglen) < msglen) { printf("VCetAcwnbr: regst to gvm failed.\n"); exit(-1); }

if ((msglen=readmsg(gvmfd,&gvbuf,"#")) < 0) { printf("vGetAcwnbr.gv read failed.\n"); exit(-1); }

gvbuf[msglen] = NUIL;

close(gvmfd);

simid = connectUN(simsoc);stropy(request, "statrogsti"); maglen = strlen(request); *acquire status table */

print("Orannosconomicalitations and printers if (writemsg(stmfd, request, msglen) < msglen) printf("WGetAcwmbr: regst to stm failed.\n"); Caria(-1); }

if ((msglen=readmsg(stmfd, &stbuf,"#")) < 0) print("VGctAcwnbr. st read failed\n"); cxif(-1);)

stbuf[msglcn] = NULL;

close(strmfd);

* make lists from the message buffers and get list sizes

* for group view and for status table

st = str2liss(stbuf, "\n=#");

print("WGctAcwnbr. st msg parsing for size failed.\n"); if (getfromlist(st, & stsizestmg, 2) = 0) {

stsize = atoi(stsizestrng); removelist(st);

* Search for myaddr in gv and return the element preceding it

* (modulo group size) that is NOT part of the status table.

myrank = GetRank(gvbuf, myaddr);

if (myranik < 0) {

printf("MGetAcwnbr: parse on myaddr search failed.\n"); exit(-1); }

gv = str2list(gvbuf, "vn=#");

printf("*GetAcwnbr. gv msg parsing for size failed.\n"); if (getfromlist(gv, &gvsizestmg, 3) == 0) { exit(-1); }

gvsize = atoi(gvsizestrng);

if (myrank == 0)

candidateposition = gvsize + GVLJSTOFFSET - 1;

candidateposition = myrank + GVLISTOFFSET - 1;

if (getfromlist(gv, &candidate, candidateposition) = 0) printf("VGetAcwnbr: parse on nbr search failed.\n"); exit(-1); }

* Check st for every group member anticlockwise from myaddr

found = FALSE; /* found the Acwnbr */

search complete = FALSE; /* finished looking but did not find one */

```
if (getfromlist(gv, &candidate, candidateposition) == 0) (
                              if (candidateposition == (myrank + GVL.ISTOFFSET)) {
                                                                                                                                                                                                                   printf("MGetAcwnbr. parse on nbr search failed.\n");
                                                          search complete = TRUE;
                                                                                            strcpy(acwnbr, myaddr); }
/* all others in st. */
                                                                                                                                                                                                                                                                                  exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        removelist(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      free(gvbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    free(stbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (InStatus Table(stbuf, candidate, (char *) NULL) = FALSE) [
                                                                                                                         while ( (found = FALSE) && (search complete == FALSE) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   candidateposition = gysize + GVLISTOFFSET - 1;
                                                                                                                                                                                                                                                                                                                                                                             if (writemsg(stmfd, request, stmsglen) < stmsglen)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if(candidateposition = GVLISTOFFSET)
                                                                                                                                                                                                                                                                                                                                                                                                       printf("vCetAcwnbr. reqst to stm failed.vn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if ((stmsglen=readmsg(stmfd, &stbuf,"#")) < 0) {</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("\GetAcwnbr: st read failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* candidate is acwribr if it is not in st */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                stropy(acwnbr, candidate); ]
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            else { /* rotate ring position */
                                                                                                                                                                                                                                                                                                                strufd = connectUN(strusoc);
                                                          stropy(acwnbr, candidate); }
                                                                                                                                                                                                                                                  strcpy(request, "statreqs#");
                                                                                                                                                                                                                                                                              stmsglen = strlen(request);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            stbuf[samsglen] = NULL;
                                                                                                                                                                                                                   /*acquire status table */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   found = TRUE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        cxit(-1); }
                              found = TRUE:
 if (straine = 0) [
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          close(stmfd);
                                                                                                                                                       free(stbuf);
```

candidateposition-

8

```
printf("vGetAcwnbr: expected flow of execution failed.\n");
} /* end else InStatusTable */
                                                                                                                                                                                                                                 if (found I search complete)
                                                    } /* end while found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* end GetAcvmbr */
```

```
************************
                                                                                                                                                                                                                                      When status is not required: InStatus Table(stbuf, candidate, (char *) NULL)
                                             InStatus Table: returns TRUE if candidate is in the status table, FALSE if not.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 nextinst = STLISTOFFSET; /*first member in st is the third field */
                                                                                             Initializes status to the value from the status table unless the address
                                                                                                                                                                                                                                                                                 When status is required: InStatusTable(stbuf, candidate, status)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             where status is the address of a memory
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("\InStatusTable: st msg parsing for size failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                            characters including the null character.
                                                                                                                                                                                                                                                                                                                                                                              allocated null terminated string of 10
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             *stmember, *stsizestmg, *sts, *suble;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           strible = CALLOC(striben(stbut) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (getfromlist(st, & stsizestrng, 2) = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* separate elements from their status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      else ( /*search the status table entries */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       int InStatus Table (stbuf, candidate, status)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                nextinst, stsize, found;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  char *stbuf, *candidate, *status;
                                                                                                                                        persect as status is NULL.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          \mathfrak{A} = \operatorname{str}2\operatorname{list}(\operatorname{strble}, \operatorname{``} \mathsf{r} \mathsf{r} = \#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* copy the status table */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        stsize = atoi(stsizestrng);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcpy(stable, stbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           found = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    found = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (string) = 0
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          exit(-1); }
```

```
while ( (found == TRUE) && (strcmp(stmember, candidate) != 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               print("VInStatus Table: initializing status failed.\n");
                          print("\InStatusTable: first parse on st failed.\n");
                                                                                                                                                                                                                                   if (getfromlist(st, & structuber, nextinst) = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (getfromlist(st, &sts, nextinst + 1) = 0) {
if (getfromlist(st, & structuber, nextinst) = 0) {
                                                                                                                                                                          nextinst += 2; /* skip the status field */
                                                                                                                                                                                                                                                                                                                                                                                                                                            if (found == TRUE) [
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } /* end if found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    strcpy(status, sts);
                                                                                                                                                                                                                                                               found = FALSE;
                                                                                                                                                                                                                                                                                                                          /* end while found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } /* end InStatusTable */
                                                                                                                                                                                                                                                                                                                                                                                   if (status!= NULL) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           CXII(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } /* end else stsize */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* cand if status */
                                                                                       exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  removelist(st);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return(found);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                free(stible);
```

```
CountDown: Decrements the location at valptr after at least

Step microsconds.

int CountDown(valptr, step)

int *valptr, step;

{
   uslcep(step);
   return(*valptr = *valptr - 1);
   return(*valptr = *valptr - 1);
} /* end CountDown */
```

void SendTkn2Agr(agrsoc, tkntype, tknsubject)

char *agrsoc, *tkntype, *tknsubject;

SendTin2Agr: A token is sent to the agreement process and the caller blocks

until the agreement process acks.

exits upon failure to send.

```
printf("\SendTkn2Agr: empty msg read failed after sending %s.\n", tkntype);
                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("vSendThn2Agr: init agree send failed for %s.\n", tkntype);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* subject fo token */
                            c[1], initiagree[INITTOKENMSGLEN+1];
                                                                                                                                                                                                                                                                                                                                                                                                               if (writemsg(agrfd, initagree, msglen) < msglen) {
                                                                                                                                                                                                                                     /* end of msg */
                                                                                                                 strcpy(initagree, "initioken\n"); /* header */
                                                                                                                                                                            /* separator */
                                                                                                                                                                                                                                                                                              /* send initiate agreement msg and block */
                                                                                                                                                 /* type */
                                                                                       /* assemble initiate agreement msg */
                                                                                                                                                                                                       streat(initagree, tknsubject);
                                                                                                                                                                                                                                                                                                                                                   agrid = connectUN(agrsoc);
                                                                                                                                                                                                                                                                                                                            msglen = strlen(initagree);
                                                                                                                                              streat(initagree, tkntype);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (read(agrfd, c, 1) < 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 } /* end SendTkn2Agr */
agrfd, msglen;
                                                                                                                                                                        strcat(initagree, " ");
                                                                                                                                                                                                                                     strcat(initagree, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            close(agrfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   exut(-1); }
```

```
while ( (found \Longrightarrow FALSE) && (rank \iff gysize-1) ) {
                                                                                                                                                              if (getfromlist(gv, &element, rank + 4) == 0)
                                                                                                                                                                                                                                                                                                    if (stremt 'element, candidate) = 0)
 gvsize = atoi(gvsizestrng);
                                                                                                                                                                                                                                                                                                                            found = TRUE:
                                                                                                                                                                                                                                                                                                                                                                                                                                      } /* end while found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (found = TRUE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* end InGroup */
                                                                                                                                                                                                                                             exit(-1); }
                                                    found = FALSE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            removelist(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             else return(-1);
                                                                                                                                                                                                                                                                                                                                                                                    else rank++;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        return(rank);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     free(gybuf);
                          rank = 0;
*gybuf, *element, request[NODATAMSG+1], *gysiz.sstrig,
                          in Group: returns the rank of the candidate from the group view. -1 if
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("VInGroup: msg persing for gv size failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     * make a list from the message buffer and get the host
                                                                                                                                                                                                                                                                                                                                                                                                                                           if (writemsg(gvmfd, request, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ( (msglen=radmsg(gvmfd, &gvbuf,"#")) < 0 ) {
                                                                                                                                                                                          found, gymfd, msglen, rank, gysize;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("\InGroup: reqst to gvm failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (getfromlist(gv, &gvsizestmg, 3) = ...
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        print("VInGroup: gv read failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                   gvmfd = connectUN(gvmsoc);
                                                                                                           int InGroup(gymsoc, candidate)
                                                      the candidate is not found.
                                                                                                                                                                                                                                                                                                                                sarcpy(request, "viewreqs#");
                                                                               ****************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         gv = str2list(gvbuf, "\n=#");
                                                                                                                                                                                                                                                                                                                                                        msglen = strlen(request);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                gvbuf[msgten] = NULL;
                                                                                                                                       char *gvmsoc, *candidate;
                                                                                                                                                                                                                                                                                                     /*acquire group view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      close(gvmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exti(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exis(-1); }
```

```
print("VGetMembWithRank: rank %d exceeds gysize - 1 %d.\n", rank, gysize - 1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      print("vGetMembWithRank: gv parsing for member of desired rank failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (getfromlist(gvlist, &desiredmember, rank + GVLISTOFFSET) = 0) [
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (geofromlist(gvlist, &gvsizestmg, GVLISTOFFSET - 1) = 0) {
                                                                                                      print("VGetMembWithRank: gv parsing for gv size failed.\n");
                                                                   printf("vGetMembWithRank: gv = 1%sNn", gvbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    *membar = CALLOC(MAXLMTSIZE + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             strcpy(*member, desiredmember);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* cnd GetMembWithRank */
                                                                                                                                                                                                              gvsize = atoi(gvsizestmg);
                                                                                                                                                                                                                                                                             if (rank > gysize - 1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* end else rank */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              removelist(gvlist);
                                                                                                                                                                                                                                                                                                                                               removelist(gvlist);
                                                                                                                                                                                                                                                                                                                                                                                                                    return(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return(0);
                                                                                                                                          exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(gv);
                                                                                                                                                                                                                                                                                                                                                                                   free(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   GetMembWithRank: returns 0 and member is initialized to the element with rank.
                                                                                                    member is the address of the first character of the member string
                                                                                                                                      to be returned. Storage is altocated for 'member' which should be
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            print("vCetMembWithRank: Illegal value of rank %d . \n", rank);
                                                                                                                                                                                                                                                                                                                                                                           if (GetMembWithRank(gvbuf, &member, n) != 0)
                                                                                                                                                                                                          Incorning group view, gybuf, must be a string.
                                                                     -1 if no member with the given rank exists.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 int GetMembWithRank(gvbuf, member, rank)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              gvsizestmg, *desiredmember, *gv;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               gv = CALLOC(strlcn(gvbul) + 1, char);
                                                                                                                                                                                                                                                                           Sample call: char *member;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* Convert the gv string to a list */
                                                                                                                                                                                                                                                                                                                                                                                                                    error processing ....;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* preserve original copy of gv */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    gvlist = str2list(gv, "vr=#");
                                                                                                                                                                         freed by the caller.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        char *gvbuf, **member;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      free(member);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                strepy(gv, gvbul);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Sylist:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             gvszc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (rank < 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           int rank;
```

```
next = TKPLISTOFFSET; /* first member in token pool is the third field */
                             InTokenPool: returns TRUE if token is in the token pool, FALSE if not.
                                                         For token equality, only checks the subject and the type,
                                                                                                                                                                                                                                                                                                                                                                                                              * make a list from the message buffer and get the pool size
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (TokensREqual(token, candidate) = TRUE) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (getfromlist(ttplist, & candidate, next) = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                    \psi = CALLOC(strien(tokenpool) + 1, char);
                                                                                                                                                                                                                                                                found, next, done;
"candidate, "poolsizestrng, "tp;
                                                                                         and ignores the originator.
                                                                                                                                               int InTokenPool(tokenpool, token)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            thplist = str2list(tp, "\r=#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                while (done = FALSE)(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ) /* end while !done */
                                                                                                                                                                             char *tokenpool, *token;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 found = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   done = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  strcpy(tp, tokenpool);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   done = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  found = FALSE;
                                                                                                                                                                                                                                                                                                                          *tkplist;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            done = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         next++;
```

```
removelist(dxplist);
frec(tp);
```

return(found);

} /* end InTokenPool */

```
if ((stremp(t1_type, \mathcal{Q}_t)ppe) = 0) && (stremp(t1_subj, \mathcal{Q}_tsubj) = 0))
                                   printf("TokensREqual: token subject parsing for token 2 failed.\n");
                                                                 if (getfromlist(list2, &t2_subj, 2) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* end TokensREqual */
                                                                                                                                                                                                                                                               equal = FALSE;
                                                                                                                                                                                                  equal = TRUE;
                                                                                                                                                                                                                                                                                                                                  removelist(list1);
                                                                                                                                                                                                                                                                                                                                                                    removelist(list2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return(equal);
                                                                                                                                                                                                                                                                                                                                                                                                                                  free(token1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 free(token2);
                                                                                                     exit(-1); }
TolconsREqual: returns TRUE if tolcon has the same subject and type as
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         print("TokensREqual: token subject parsing for token 1 failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          print("TokensREqual: token type parsing for token 2 failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              printf("TokensREqual: token type parsing for token 1 failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            "token1, "token2, "t1_type, "t2_type, "t1_subj, "t2_subj;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              token2 = CALLOC(strken(candidate) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             icken1 = CALLOC(strken(icken) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (getfromlist(list2, &t2_type, 1) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (getfromlist(list1, &t1_type, 1) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (getfromlist(list1, &tt1_subj, 2) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                * make local copies first to create lists
                                                                                                                                int TokensREqual(token, candidate)
                                                                   candidate, FALSE if not.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               list 1 = str2list(token1, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             ist2 = str2list(token2, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  stropy(token2, candidate);
                                                                                                                                                                    char *roken, *candidate;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 stropy(token1, token);
                                                                                                                                                                                                                                                                                                                                  "list], "list2;
                                                                                                                                                                                                                                                                   consi;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exis(-1); )
                                                                                                                                                                                                                                                                                                   M
```

```
if (strcmp(element, candidate) = 0)
                               found = TRUE;
                                                                                                                                            /* end while found */
                                                                                                                                                                                                                                                                                         if (found == TRUE)
                                                                                                                                                                                                                                                                                                                                                                                                                                  } /* end GetRank */
                                                                                      rank+;
                                                                                                                                                                                                     removelist(gvl);
                                                                                                                                                                                                                                                                                                                        return(rank);
                                                                                                                                                                                                                                                                                                                                                                              return(-1);
                                                                                                                                                                                                                                   free(lgv);
                                                                                                                  · 李林林林林林林林林林林林林林林林林林林林林林林林林林林林
print("VGetRank: gvl parsing for element rank %d failed.\n", rank); print("V7SSSSSSSSSSSSSSSSSSSSSSSS");
                           GetRank: returns the rank of the candidate from the group view. -1 if
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    * make a list from the local copy and search for the candidate
                                                     the candidate is not found. Requires the caller to supply a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("VGetRank: msg parsing for gysize failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        while ( (found == FALSE) && (rank \leftarrow= gysize - 1) ) {
                                                                                                                *************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (getfromlist(gvl, &clement, rank + 4) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (getfromlist(gv), &gvsizestmg, 3) = 0) {
                                                                                                                                                                                                                                                                                       *lgv, *element, *gvsizestmg;
                                                                                   string containing the group view.
                                                                                                                                                                                                                                                             found, gylen, rank, gysize;
                                                                                                                                                                                                                                                                                                                                                                                                  lgv = CALLOC(gvlcn+1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              gysize = atoi(gysizestmg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          gv1 = str2hist(lgv, "n=#");
                                                                                                                                            int GetRank(gv, candidate)
                                                                                                                                                                        char *gv, *candidate;
                                                                                                                                                                                                                                                                                                                                                                            gvien = strien(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 cxit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                found = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                     strapy(lgv, gv);
                                                                                                                                                                                                                                                                                                                   Ž
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exil(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     rank = 0;
```

```
GetGroupSize: returns the group view size. Requires the caller to supply a
                                                                                                                int GetGroupSize(gv)
print("VGCTokenType: local token parsing for type failed.h"); print("V788888888888888888888888888);
                               GetTokenType: does not disturb the token passed in.
                                                       returns -1 if the token type is invalid.
                                                                                                                                                                                                                            htm[TOKENLEN+1], *tkntype;
                                                                                                                                                                                                                                                                                                                                                                                                      if (getfromlist(tknl, &tkntype, 1) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (stremp(tlantype, "joincomit") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (stremp(tkntype, "failcomit") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (stremp(thoughe, "joinagree") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (seconp(thoughe, "failagree") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (stremp(tkntype, "joinregst") == 0)
                                                                                                                int CetTokenType(token)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               type = JOINAGREE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      type = JOHNCOMITT;
                                                                                                                                                                                                                                                                                                                                             trnl = str2list(ltlm, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  type = FAIL AGREE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           type = FAILCOMIT;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               type = JOINROSTT;
                                                                                                                                                                                                                                                                                                                   strcpy(ltlm, token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       removelist(tknl);
                                                                                                                                                                                                                                                           *ten!
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return(type);
                                                                                                                                               char hoken:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          cxit(-1);}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   type = -1;
```

/* end GefTokenType */

```
printf("vGetGroupSize: msg parsing for gysize failed.\n");
                                                                                                                                                                                                                                                                                                                                                                if (getfromlist(gvl, &gvsizestmg, 3) == 0) {
                                                                                                                                                                                                                                                                         * make a list from the local copy
                                                                                                                                                                              Igv = CALLOC(gvlen+1, char);
                                                                                        *lgv, *gvsizestmg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 gvsize = atoi(gvsizestrng);
                                                                                                                                                                                                                                                                                                                     gvl = str2list(lgv, "\n=#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* and GetGroupSize */
                                                                gvsize, gvlen;
                                                                                                                                                            gvlen = strlen(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      removelist(gvl);
                                                                                                                                                                                                        strcpy(lgv, gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return(gvsize);
                                                                                                              *
                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(lgv);
char *gv;
                                                                                       char
```

string containing the group view.

```
******************
                              GetStatus: returns the status of the candidate from the status table. -1 if
                                                            the candidate is not found. Requires the caller to supply a string
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (InStatus Table(st, candidate, status) == TRUE) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (stremp(status, "joincomit") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (strcmp(status, "failcornit") == 0)
stat = FAILCOMIT;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (succrup(status, "joinagree") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (seromp(status,"joinnqsed") == ()
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (strcmp(status, 'failagree') = 0)
                                                                                                                                                                                                                                                                                                                                                                                                         status = CALLOC(9 + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /* if subject is in status table */
                                                                                             containing the status table.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           STAR = JOINAGREE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  STR = FAIL AGREE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      STRE - JOINCOMIT;
                                                                                                                                                        int GetStatus(st, candidate)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     SER = JOINROSTT;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end GetStatus */
                                                                                                                                                                                        cher *st, *candidate;
                                                                                                                                                                                                                                                                                 char *sanus;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return(stat);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    free(status);
                                                                                                                                                                                                                                                                                                                                                  Stat = -1;
                                                                                                                                                                                                                                                         int Stat.
```

```
gy_size. The relative rank of the original process is zero. Returns
                                        RelativeRank: returns the relative rank of the subject wrt origin. Modulo
*********************
                                                                                                              (-1) if either subject, or origin are not in group view.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* calculate the rr (assuming subject and origin in gv) */
                                                                                                                                                                                int RelativeRank(gv, subject, origin)
                                                                                                                                                                                                                                                                                                                                                           rank_s = GetRank(gv, subject);
                                                                                                                                                                                                                                                                                                                                                                                             rank_o :: GetRank(gv, origin);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if ((rank_s < 0) \text{ # } (rank_o < 0))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         \pi = \pi + GetGroupSize(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* check for error condition */
                                                                                                                                                                                                                  char *gv, *subject, *origin;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } /* end RelativeRank */
                                                                                                                                                                                                                                                                                       int rank_s, rank_o, rr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     r = rank_s - rank_o;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return (rr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    return(-1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if(\pi < 0)
```

```
GetStatusTable: returns a pointer to the status table. Requires strnsoc as a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("vGetStatusTable: status table request failed.vn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            print("vGetStatusTable: status table read failed.\n");
                                                                                                                                                                     buf = GetStatusTable(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (writemsg(stmfd, streq, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if ( (msglen=readmsg(stmfd,&st,"#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              char streq[NODATAMSG+1], *st;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strnfd = connectUN(strnsoc);
                                                                                                                                                                                                                                                                                                                                                                  char *GetStatusTable(stmsoc)
                                                                                                                                                                                                                                                                                    free(but);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  strcpy(streq, "statreqst#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         msglen = strlen(streq);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        st[msglcn] = NULL;
                                                                                                                Typical call:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* get status table */
                                                              parameter.
                                                                                                                                                                                                                                                                                                                                                                                                                                                      int msglen, stmfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     close(stmfd);
                                                                                                                                                                                                                                                                                                                                                                                                char *strnsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           return(st);
                                                                                                                                                                                                                                                                                                                                        /************************
*****************
                                GetGroup View: returns a pointer to the group view. Requires gymsoc as a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                print("MGetGroupView: group view request failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("vCetCroupView: group view read failed.\n");
                                                                                                                                                                     buf = GetGroupView(gvmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (writemsg(gvmfd, gvreq, msglen) < msglen) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if ( (msglen=readmsg(gvmfd,&gv,"\#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              char gyreq[NODATAMSG+1], *gv;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      gvmfd = cornectUN(gvmsoc);
                                                                                                                                                                                                                                                                                                                                                                   char *GesCroupView(gvmsoc)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  strcpy(gvreq, "viewreqst#");
                                                                                                                                                                                                                                                                                    free(but);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* get local group view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               msglen = strlen(gvreq);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        gv[msglen] = NULL;
                                                                                                                Typical call:
                                                                                                                                                                                                                                                                                                                                                                                                                                                        int msglen, gymfd;
                                                              perameter.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        close(gvmfd);
                                                                                                                                                                                                                                                                                                                                                                                                  char *gvmsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return(gv);
```

```
*************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         committoken: return TRUE if tokentype = FAIL AGREE or JOINAGREE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ***********************
                           agreetoken: return TRUE if tokentype = FAILAGREE or JOINAGREE
                                                       ******************
                                                                                                                                                                                                                                                                          if ((tokentype == FAILAGREE) | (tokentype == JOINAGREE))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if ((tokentype == FAILCOMIT) II (tokentype == JOINCOMIT))
                                                                                                                                                                                                                     tokentype = GetTokenType(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tokentype = GetTokenType(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       } /* end comittoken */
                                                                                                                                                                                                                                                                                                                                                                                                              /* end agreetoken */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             int comittoken(token)
                                                                                 int agreetoken(token)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return(FALSE);
                                                                                                                                                                                                                                                                                                                                                        return(FALSE);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             return(TRUE);
                                                                                                                                                                                                                                                                                                    return(TRUE);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         int tokentype;
                                                                                                                                                                 int tokentype;
                                                                                                             char *token;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           char *token;
                                                                                                                                                                                                                                                                                                                                GetTokenPool: returns a pointer to the token pool. Requires turnsoc as a
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("vGetTokenPoot: token pool request failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      printf("VGeTokenPool: token pool read failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (writemsg(tymid, tyreq, msglen) < msglen) {
                                                                                                                                                                 buf = GeffokenPool(tymsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if ( (msglen=readmsg(tpmfd,&tp,"#")) < 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 char tpreg[NODATAMSG+1], *tp;
                                                                                                                                                                                                                                 :
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printid = connectUN(tpmsoc);
                                                                                                                                                                                                                                                                           free(but);
                                                                                                                                                                                                                                                                                                                                                        char *GefTokenPool(tpmsoc)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               stropy(tpreq, "tokpreqst#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* get local token pool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           msglen = strlen(tpreq);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             tp[msglcn] = NULL;
                                                                                                             Typical call:
                                                                                                                                                                                                                                                                                                                                                                                                                                        int meglen, tpmfd;
                                                          parameter.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       close(tpmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exii(-1); }
                                                                                                                                                                                                                                                                                                                                                                                      char **pmsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return(tp);
```

return FALSE if token has been processed. A token has been processed for the following conditions:

if join -> has been processed if subj mbr GV

if fail -> has been processed if subj NOT mbr GV

return TRUE otherwise.

NOTE: it is not necessary to detect all possible outcomes... the token is checked for prior processing ONLY if it is in the external token pool and not the local token pool. This condition can only occur if: the token has never been seen at this member, or the token has been deleted. If the token has been deleted, the corresponding comit must have occured. Thus, check only the final result as intermediate stages do not effect the local token pool.

```
int first_time(token, gv, st)

char *noken_r*gv, *st;

int token_rype, rtnval = TRUE;

char *unptin, *subject;
link *ulist;

unptin = CALLOC(surlen(token) + 1, char);

strcpy(unptin, token);

tist = str2list(unptin, "#");

if (getfromliss(tlist, &subject, 2) == 0) {

printf("Virst_time: parsing failed token subj:\n");

printf("Virst_time: parsing failed token subj:\n");

printf("Violen = 1%s\n", token);

printf("Violen = 1%s\n", token);

printf("Violen = 1%s\n", token);
```

/* get the token type */

exit(-1); }

```
printf("ProcessTokenPool: (first_time) invalid tokentype\n");
                                                                                                                                                                                                                                                                                                                   if (GetRank(gv, subject) == -1) /* subj NOT in GV */
                                                                                                                                                         if (GetRank(gv, subject) != -1) /* subj in GV */
token_type = GetTokenType(token);
                                                                                                                                                                                                                                                                                                                                                                                                                         default: /* error condition */
                                                                                                                                                                                                                                                                                                                                             rtnval = FALSE;
                                                                                                                                                                                  rmval = FALSE;
                                                                                                                                                                                                                                                               case FAIL AGREE:
                                                                          case JOINRQSTT:
                                                                                                      case JOINAGREE:
                                                                                                                                                                                                                                                                                        case FAILCOMIT:
                                                                                                                             case JOINCOMIT:
                                               switch (token_type)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       cxit(1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* end first_time */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    removelist(tlist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return(rtnval);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(tmptkn);
```

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```
*************************
                                                                                                                                                                                                                                         In the original string, tokens are replaced by NULL
                                                                       of which points to a field of the original string.
                                                                                                                                                                         After the list is no longer needed, removelist()
                                                                                                     The fields are originally separated by token.
                                         str2list - parse a string, creating a list of nodes, each
                                                                                                                                                                                                       must be called for garbage collection.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           tmp->data = ptr = strtok(str,token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        tmp = msglst = CALLOC(1, link);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         while (ptr = strtok(NUL_Ltoken)) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ump->next = CALLOC(1, link);
                                                                                                                                                                                                                                                                           *str2list(str, token)
                                                                                                                                                                                                                                                                                                                                                                                                                                            *msglst, *ump;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           tmp = tmp->next;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           tmp \rightarrow data = ptr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      } /* end str2list */
                                                                                                                                                                                                                                                                                                                                        *token:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           return(msglst);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Ħ,
                                                                                                                                                                                                                                                                                                          ķ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          char
                                                                                                                                                                                                                                                                                                                                                                                                                                            真
                                                                                                                                                                                                                                                                                                      char
                                                                                                                                                                                                                                                                                                                                        Char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *******************************
                                                                                                                                                                                                       cher *list2su(link *list, cher *header, cher* hock, cher *lick);
                                       * MESSAGE HANDLING AUXILIARY FUNCTIONS (msguille)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Other functions in this file are used internally, and should
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Refer to the function header comments for detailed info.
                                                                                                                                                                                                                                                                                                                                          char *int_2_ext(char *inmsg, int sumbr, char *orig);
                                                                                                         The following functions are available to be used:
                                                                                                                                                                                                                                                                                                          int getfromlist(link *list, char **str, int n);
                                                                                                                                                                         ink *str2list(char *str, char *token);
                                                                                                                                                                                                                                                                                                                                                                                                                                        intext_msg_type(char *extinsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            char *get_originator(char *str);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            char *get_ext_target(char *str);
                                                                                                                                                                                                                                                                                                                                                                                                          int in msg_type(char *inmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          char *get_target(char *str);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Fernando J. Pires
                                                                                                                                                                                                                                         void removelist(link *list);
                                                                                                                                                                                                                                                                                                                                                                          int get_sr_nbr(char *msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           David Pezdirtz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      27 Jul 1993
                                                                                                                                                                                                                                                                           nt listsize(link *list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           not be used directly.
```

struct link*next; };

char*data;

Struct link (

* Last revision:

Writen by:

typedef struct link link;

```
Ion += strien(ptr->data) + 1; /* Reserve space for token and NULL */
                                                                                                                                                                                                                                                                                                                                            The resulting message has to be deallocated
                                                                                          inserted in between each new field and a NULL is
                                                                                                                                                                                                                                                                              If the list is empty the header is returned
                                                                                                                                                                                     header has to be dynamically allocated
                                                                                                                                                                                                                                             initialize it is to use "header = CALLOC(1,char);"
                                                                                                                                                                                                                                                                                                                                                                        with a free() call when it is no longer needed.
                          str2list() and appends it to the string header.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        header = REALLOC(header, strlen(header) + 2 + len, char);
                                                                                                                                                                                                                 (it cannot be static data). The best way to
list2str - assembles a string from a list generated by
                                                          htok' is inserted after the header. Trok' is
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 while (ptr) { /* determine size of string to be used */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   streat(header, htok); /* insert htok */
                                                                                                                      added at the end.
                                                                                                                                                                                                                                                                                                              without changes.
                                                                                                                                                                                                                                                                                                                                                                                                                                        char* list2str(list, header, htok, ltok)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ptr=ptr->next; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      74=15;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Jen = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   *header,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * teck;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (hack)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (lean) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (list) [
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Ĭ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Ž
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Ş
```

while (list) { /* assemble the string */

```
strcat(header, list->data);
list = list->next;
```

if (list &&& hoit) /*add ltok except after last field*/
strcat(header,ltok);

} /* end while list */

} /* end if len */

} /* end if list */

return(header);

} /* end list2str */

```
removelist - Deallocates the space used by st7list() to
generate a list. This function must be called for
every list, once it is no longer needed.

wid removelist(list)
link *list;
{
    if (list->next)
    removelist(list->next);

free(list);
} /* end removelist */
```

```
· 一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的一个,我们的
                     getfromlist - Get the nth field from list. Upon execution 'st'
                                                             Returns n if the call is successful, or zero if the
                                                                               list has less than n fields.
                                          points to the nth field.
                                                                                                                                                                                                                                                                                                                                                                                                                          p = getfrom list(list->next, str,n-1);
                                                                                                                         getfromlist(list, str, n)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         } /* end getfromlist */
                                                                                                                                                                                                                                                                                                                                           if (n == 1) {
*str = list->data;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return(n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            return(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 } /* end else n */
                                                                                                                                                                                                                                                                                  if(list = NULL)
                                                                                                                                                               **
                                                                                                                                            *
≅
                                                                                                                                                                                                                                                                                                                                                                                    return(n); }
                                                                                                                                                                                                                                                                                                         return(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (p)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         क्ष
                                                                                                                                                                                                                                             int p;
                                                                                                                                                             char
int
                                                                                                                                         斯
```

int_2_ext - convert 'inmsp' into an external message.

'sn or is converted to a string and is used as a p. sfix to 'inmsg'. 'orig' is the address of the

local element and it is inserred after 'snrb'.

```
To convert an internal massage to external format use:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 extrasg = CALLOC(strlen(temp) + strlen(orig) + msgsize + 2, char);
                                                                                                                                                                                                      If the serial number is not relevant set 'snbr' to 0.
An NL character is used to separate the fields.
                                                                                                extrnsg = int_2_ext(nmsg, smbr, orig);
                     The original immsg' is not modified.
                                                                                                                                                                                                                                                        char *int_2_ext(inmsg, smbr, orig)
                                                                                                                                                   free(extrnsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                 temp[HEADERSIZE];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         sprintf(temp, "%dn", smbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 msgsize = strlen(inmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     streat(extrnsg, inmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             strcpy(extrnsg, temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      streat(extmsg, orig);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } /* end int_2_ext */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             streat(extrnsg,"\n");
                                                                                                                                                                                                                                                                                                                                                                                                                msgsize;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   *extmsg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 return(extrnsg);
                                                                                                                                                                                                                                                                                                                                     *ong:
                                                                                                                                                                                                                                                                                char *inmsg;
                                                                                                                                                                                                                                                                                                            int smbr,
                                                                                                                                                                                                                                                                                                                                                                                                                                       char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                char
```

```
get_sr_nbr - extracts the serial number of a message that
                                                                                                                           The function returns the serial number, or -1
                                                   was previously retreived from the queue, or
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (geofromiss(list, & smbrstr, 1) != 1) { /* get 1st field */
                                                                                                    The original message is not disturbed.
                                                                            received at the external port.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* break the message into a list of fields */
                                                                                                                                                                                                                                                                                                                                                                              /* make a copy of the message */
tmp = CALLOC(strien(msg) + 1, char);
                                                                                                                                                      if an error occurs.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              print("get_sr_nbr error\n");
                                                                                                                                                                                                                                                                                                    "ump, *smbrstr;
"list;
                                                                                                                                                                                                      get sr_nbr(msg)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      list = str2list(tmp, "\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        return(atoi(smbrstr));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* end get_s _nbr */
                                                                                                                                                                                                                                                                                                                                                                                                                               strepy(tmp, msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       return(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               free(trup);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(trmp);
                                                                                                                                                                                                                                                                                                       Char
                                                                                                                                                                                                      曹 曹.
```

```
the type of the string type', as defined in gmp.h
                                                   msg_type - returns the integer value correponding to
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (secmp(type, "groupview") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (stremp(type, "updatview") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (sincmp(type,"viewreqst") = 0)
                                                                                                                                                                                                                                                                                                                                                                                if (stremp(type, "tokenackn") = 0)
                                                                                                                                                                                                                                                                       if (stremp(type, "tokentokn") = 0)
                                                                                                                                                                                                                                                                                                                              if (stremp(type,"tokenpool") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (strcmp(type,"initperam") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                \mathbf{f} (streng(type,"updstatus") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (stremp(type, "sndinipar") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 If (stremp(type,"initioken") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                        if (stremp(type,"statusqry") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (seconp(type, "satustpt") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (stremp(type, "joinregst") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  f(strcmp(type,"statustbi") == 0)
                                                                                                                                                                                                               in manype = INVALDMSG;
                                                                                                                                                                                                                                                                                                                                                                                                          msgrype = TOKENACKN;
                                                                                                                                                                                                                                                                                                  msgrype = TOKENTOKN;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            magaype = GROUPVIEW;
                                                                                                                                                                                                                                                                                                                                                     msgype = TOKENPOOL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 msgrype = STATUSQRY;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   msgrype = UPDATVIEW;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      magnype = STATUSRPT;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          megtype = STATUSTBL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               msgype = INTTPARAM;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               magnype = VIEWREQST;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         magaype = UPDSTATUS;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           msgrype = INITTOKEN;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    msgrype = JOINREQST;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      msgrype = SNDINIPAR;
                                                                                                                                        msg_type(type)
```

```
if (stremp(type, "extknipool") = 0)
                                                                                                                                                                                                                                                             if (stremp(type, "timeout_") == 0)
                                                                                                   f(strcmp(type,"initgview") = 0)
                                                                                                                                                                                                                                                                                                                                                                  if (stremp(type, "delttoken") = 0)
                                                    f(strcmp(type,"tolepreqst") == 0)
                                                                                                                                                                                                                                                                                                                 if (strcmp(type,"starttinn") = 0)
f (stremp(type,"statreqst") == 0)
                                                                                                                                                       if (strcmp(type,"initable") == 0)
                                                                                                                                                                                                             if (strcmp(type, "inittpool") = 0)
                                                                                                                                                                                                                                                                                                                                                                                          msgtype = DELTTOKEN;
                                                                                                                                                                                                                                                                                                                                                                                                                                              msgtype = EXTKNPOOL;
                       msgtype = STATREOST;
                                                                           msgtype = TOKPREOST;
                                                                                                                                                                                                                                                                                                                                       msgtype = STARTTIMR;
                                                                                                                                                                                                                                                                                 msgtype = TIMEOUT_;
                                                                                                                             msgtype = INITGVIEW;
                                                                                                                                                                                 msgtype = INITTABLE:
                                                                                                                                                                                                                                  magtype = INITTPOOL;
```

return(msgtype);

/* end msg_type */

```
char
The function returns an integer whose value is
                           in_msg_type - extracts the type field of a message that
                                                    was previously received at the internal port.
                                                                                                                             defined in 'gmp.h', or -1 if an error occurs.
                                                                             The original message is not disturbed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (geofromliss(list, & type, 1) != 1) { /* get 1st field */
                                                                                                                                                                                                                                                                                                                                                                                                        ump = CALLOC(strlen(inmsg) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* break the message into a list of fields */
                                                                                                                                                                                                                                                                                                                                                                                 /* make a copy of the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    print("in_msg_type emor\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      msgtype = msg_type(type);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            list = str2iist(tmp, "\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end in msg_type */
                                                                                                                                                                                 int in msg_type(inmsg)
                                                                                                                                                                                                                                                                                                        *mp, *type;
*list;
                                                                                                                                                                                                                                                                                                                                                                                                                                   strcpy(tmp, immsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  removelist(list);
                                                                                                                                                                                                                                                                                   msgtype;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return(msgtype);
                                                                                                                                                                                                       *inmsg:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(trmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     free(ump);
                                                                                                                                                                                                                                                                                                          횽
```

```
The function returns an integer whose value is
ext_msg_type - extracts the type field of a message that
                          was previously received at the external port.
                                                                                                             defined in 'gmp.h', or -1 if an error occurs.
                                                       The original message is not disturbed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (getfrom list(list, & type, 3)!=3) ( /* get 2nd field */
                                                                                                                                                                                                                                                                                                                                                                                                 tmp = CALLOC(strlen(extrnsg) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* break the message into a list of fields */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("ext_msg_type error\n");
                                                                                                                                                                                                                                                                                                                                                                         /* make a copy of the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               msgtype = msg_type(type);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   list = str2list(tmp, "\r#");
                                                                                                                                                                        in cat_msg_type(extmsg)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* endext_msg_type */
                                                                                                                                                                                                                                                                                     *mp, *type;
*list;
                                                                                                                                                                                                                                                                                                                                                                                                                                  strepy(unp, extrnsg);
                                                                                                                                                                                                                                                             msgtype;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                removelist(list);
                                                                                                                                                                                                     *extmsg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  return(msgtype);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(tmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       free(tmp);
```

```
The original message is not disturbed. The result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         is stored on a dynamic array inbr, that has to
                          get_originator - extracts the originator field from the
                                                  header of an external message.
                                                                                                                             be deallocated before reusing.
                                                                                                                                                                                                                                                               nbr = get_originator(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   nbr = CALLOC(strien(mbr) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tmp = CALLOC(strlen(str) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (getfromlist(list, &mbr, 2) != 2) {
                                                                                                                                                                                                            *nbr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("get_originator error\n");
                                                                                                                                                          Sample call:
                                                                                                                                                                                                                                                                                                               free(nbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *nbr, *unbr, *ump;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* end get_originator */
                                                                                                                                                                                                              char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      list = str2list(tmp,"\n");
                                                                                                                                                                                                                                                                                                                                                                     char *get_originator(str)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               strcpy(nbr,unbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           strcpy(tmp,str);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   return (nbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         free(tmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Char
Par
                                                                                                                                                                                                                                                                                                                                        The original message is not disturbed. The result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      print("get_target : string is !#s4n", str);
print("U7$$$$$$$$$$$$$$$$$$$$$$$$");
                                                                                                    is stored on a dynamic array inbr', that has to
                       get_target - extracts the destination field of an
                                                                                                                            be deallocated before reusing.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           nbr = CALLOC(strien(nbrtmp) + 1, char);
                                                                                                                                                                                                                                                               nbr = get_target(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (geofromlist(list, &nbrtmp, 2) !=2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      trmp = CALLOC(strien(str) + 1, char);
                                               internal message.
                                                                                                                                                                                                         ţ,
                                                                                                                                                        Sample call:
                                                                                                                                                                                                                                                                                                                                                                                                                                            *nbr, *nbrump, *ump;
*list;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                print("get_target error");
                                                                                                                                                                                                                                                                                                               free(nbr);
                                                                                                                                                                                                            char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    list = str2list(tmp,"\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(nbr, nbrtmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end get_target */
                                                                                                                                                                                                                                                                                                                                                                   char *get_target(str)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    strcpy(tmp,str);
```

Ė

return (nbr.);

free(trmp);

exif(-1); }

```
The original message is not disturbed. The result
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             is stored on a dynamic array 'ntr', that has to
                         get_ext_target - extracts the destination field of an
                                                                                                                    be deallocated before reusing.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         print("get_ext_target: string is 1%shn", str);
                                                                                                                                                                                                                                        nbr = get_ext_target(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    nbr = CALLOC(strien(nbrtmp) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (genfromlist(list, &nbrtmp, 4) != 4) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tmp = CALLOC(strlen(str) + 1, char);
                                               external message.
                                                                                                                                                                                          ř.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("get_ext_target enorh");
                                                                                                                                             Sample call:
                                                                                                                                                                                                                                                                                                                                                                                                                              *nbr, *nbrump, *ump;
                                                                                                                                                                                                                                                                                     free(nbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    / cend get_ext_larget */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                list = str2list(tmp, "\n");
                                                                                                                                                                                             char
                                                                                                                                                                                                                                                                                                                                     char *get_ext_target(str)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(nbr, nbrump);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                removehist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(tmp,str);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exi(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return (nbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 free(trmp);
```

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```
if (getsockname(sockfd, (struct sockadd: *) &sin, &sinlen > (0) {
                                  if ((sockid = socket(PF INET, SOCK DGRAM, 0)) < 0) [
                                                                                                                                                                                                                                                                                             if ( bind(sockfd, (struct sockaddr *) &sin, sinken > () {
                                                                printf("AcreateUDP: can't open internet socket \n");
                                                                                                                                                                                                                                                                                                                            printf("AcreateUDP: can't bind local address \n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         printf("vcreateUDP: can't bind local address \n");
     /* Open the socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  } /* end createUDP */
                                                                                                                                                                                                /* Bind the socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        "port = sin.sin_port;
                                                                                                                                                                                                                                   sinlen = sizeof(sin);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return sockfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        exit(1); }
                                                                                                                                    exit(1); }
/************************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* Internet endpoint address */
                                                                                                                                                                                                                                                                                                                            woid semmsg(char *msg, int n, char *IPaddr, u_short port);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* clear address structure */
                                                                                                                                                                                                                                                                                                                                                                                                                                                          Other functions in this file are used internally, and should
                                                                                                                                                                                                                                                                                                                                                                                                                           Refer to the function header comments for detailed info.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* socket descriptor */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 create UDP - establish an UDP socket for a server
                                                                                                     The following functions are available to be used:
                                    * SOCKET INTERFACE AUXILIARY FUNCTIONS
                                                                                                                                                                                                                                                                int readmag(int fd, char **ptr, char *com);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      sin sin_addr.s_addr = hioni(INADDR_ANY);
                                                                                                                                                                                                                                                                                               int writemsg(int fd, char *ptr, int n);
                                                                                                                                                                                                                               in connectUN(char *server_path);
                                                                                                                                                                                                                                                                                                                                                             int recmsg(int fd, char **str, );
                                                                                                                                                               int createUDP(u_short port);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Fernando J. Pires
                                                                                                                                                                                                  int createUN(char *path);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              ·É
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        bacro((char*)&sin, sizeof(sin));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        18 Feb 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             not be used directly.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     sin. sin_family = AF_INET;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       sin.sin_port = *port;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              struct sockaddr in
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 int createUDP(port)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             society
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          sinken;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Last revision:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       Writen by:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  u_short *port;
```

```
/* Internet endpoint address */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* clear address structure */
                           createUN - establish an Unix Domain socket for a server
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* in case it was left open by a previous call */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if ((socktd = socket(AF_UNIX, SOCK_STREAM, 0)) < 0) {
                                                                                                                                                                                                                                                     /* Addr struct length */
                                                                                                                                                                                                                            /* socket descriptor */
                                                                                                                                                                                                                                                                                                                                                                                              sunion = strion(sunx.sun_path) + sizeof(sunx.sun_family);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (bind(sockfd, (struct sockaddr *) & sunx, sunten \times 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          print("vcreateUN: can't open unix socket \n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      printf("kcreateUN: can't bind local path \n");
                                                                                                                                                                                                                                                                                                            bacro((char*)&sunx,sizeof(sunx));
                                                                                                                                                                                                Sumx;
                                                                                                                                                                                                                                                                                                                                       sunx sun_family = AF_UNIX;
                                                                                                                                                                                                                                                                                                                                                                    strcpy(sunx.sun_path, path);
                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* Open the socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /* Bind the socket */
                                                                                                                                                                                               struct sockaddr_un
                                                                                 in create UN(path)
                                                                                                                                                                                                                          social:
                                                                                                                                                                                                                                                     Sunien;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      unlink(path);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  return sockfd;
                                                                                                               Ą
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exi(1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cxis(1); )
```

int cornect UN(server_path)

server path

t egg

cornectUN - establish an Unix Domain socket for a client

/* Internet endpoint address */

SLINX;

struct sockaddr_um

sockit; sunkn; /* clear address structure */

bacro((char*)&sunx,sizeof(sunx));

sunx.sun_family = AF_UNIX;

sunten = strten(sunx.sun_path)+sizeof(sunx.sun_family);

strcpy(sunx.sun_path, server_path);

/* Addr struct length */

/* socket descriptor */

/* end createUN */

```
int writen(fd, ptr, nbytes)
                                                                                         register char
register int
                                                                            register int
                                                 Use in place of read() when fd is a stream socket
                         readn - Read "n" bytes from a descriptor
                                                                                                                                                                                                                             mead = read(fd, ptr, nleft);
                                                                                ich zer.
                                                                                                                                                                                                                                                          if ( mead < 0)
return(mead);</pre>
                                                                                                                                                                                                                                                                                                    if(mead = 0)
                                                                     in reach (fd, ptr, nbytes)
                                                                                                                                                                                                                                                                                                                                                                                                                    return(nbytes - nleft);
                                                                                                                                                       nleft, mead;
                                                                                                                                                                                                                                                                                                                  break;
                                                                                                                                                                                                                                                                                                                                                                                         } /* card while */
                                                                                                                                                                                                               while (nleft > 0) {
                                                                                                                                                                                                                                                                                                                                                nleft -= mead;
                                                                                                                                                                                                                                                                                                                                                              per += mead;
                                                                                                                                                                                     nleft = nbytes;
                                                                                                            register int
                                                                                                register char
                                                                                    register and
                                                                                                                                                         돌.
```

/* and readin */

```
nwriten = write(fd, ptr, nleft);
                                                                                                                                                return(nwriten);
nleft, nwriten;
                                                                                                                                                                                                                                                                            return(nbytes - nleft);
                                                                                                                                                                                                      ptr += nwriten;
                                                                                                                             if ( nwriten < 0)
                                                                                                                                                                                    nleft -= nwriten;
                                                                                                                                                                                                                                        } /* end while */
                                                                        while (nleft > 0) (
                                                                                                                                                                                                                                                                                                                 /* end writen */
                                    nleft = nbytes;
 .5
```

Use in place of wite() when fd is a stream socket

*ptr, nbytes;

둈

writen - Write "n" bytes to a descriptor

```
* allocate space for message and extra NULL*/
                                                                                                      *ptr = tmp = CALLOC(maxlen + 1, char);
                                                                                                                                                             /* get message character by character */
if ((maxlen = atoi(msghead)) == 0)
                            return(0);
                                                                                                                                                                                                                                                                                                                                                                                     अ
 an extra NULL (to be used by the calling function).
                                                                                    The message is assumed to be terminated by 'eom'.
                                                                                                              The function allocates the necessary space to build
                                                                                                                                                                                              The calling function must free the allocated space,
                                                                                                                                         a non-Null terminated string "str', plus space for
                                                        Use in place of read() when fd is a stream socket
                                 readmsg - Read a complete message from a descriptor
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 c, msghead[HEADERSIZE+1], *ump;
                                                                                                                                                                                                                                                                                                                                                                                         len = readmsg(fd, &str, "#");
                                                                                                                                                                                                                          when it is no longer necessary.
                                                                                                                                                                                                                                                                                                                                                                                                                 str[km] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   *tmp++ = c; } while( c!= '~);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if ((rc = read(fd, &cc, 1))!= 1)
                                                                                                                                                                                                                                                                                Sample call sequence:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  *******
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        free(str);
                                                                                                                                                                                                                                                                                                                                     char *st;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                eom,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                int readmsg(fd, ptr, com)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          n, rc, maxlen;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               return(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* get msg size */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ump = msghead;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  register char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            register char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           register int
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 . E
```

-emp = NULL; / substitute NULL for '~' to end string */

```
/* Note: the calling function has to free the allocated space */
                                                                                                                                                                                                                                                                                                   /* EOF, data was read */
                                                                                                                                                                                                                                          /* EOF, no data read */
                                                                                                                    /* End of message */
                                                                                                                                                                                                                                                                                                                                                                                                         /* error */
                                      if ((\mathbf{r} = \text{read}(\mathbf{fd}, \&c, 1)) == 1) {
for (n = 1; n \le maxlen; n++) {
                                                                                                                                                                                                                                             return(0); }
                                                                                               if (c = *eom)
                                                                                                                                                                                                                                                                                                                                                                                                       return(-1); }
                                                                                                                                                                                                                       free(*ptr);
                                                                                                                                                                                                    if(n=1) \{
                                                             *tmp++=c;
                                                                                                                                                             if(rc=0)
                                                                                                                                                                                                                                                                                                      break:
                                                                                                                                                                                                                                                                                                                                                                                    free(*ptr);
                                                                                                                   break; )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* end readmsg */
                                                                                                                                                                                                                                                                                                                                                                                                                                               } /* end for */
                                                                                                                                                                                                                                                                                                                                                                 else {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      return(n);
```

```
**************************
                                                                                                                                                                                                              the original message that were actually transmitted.
                                                                                        contains the size of the original message, plus a '~'
                                                                                                                    as a separator. This header is to be processed by
                               writering - Writes a complete message pur of size h' to a
                                                         file descriptor Yd". It appends an header that
                                                                                                                                                                                                                                                                                                                                                               n = writemsg(fd, str, strken(str));
                                                                                                                                                                                 It returns the number of characters from
                                                                                                                                                                                                                                          The original message is not changed.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           msg = CALLOC(n+strlen(header) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           header[HEADERSIZE + 1], *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  nwrite = writen(fd, msg, strlen(msg));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     return(nwrite-strlen/header));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             sprintf(header, "%d-", n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (n > (len = strlen(ptr)))
                                                                                                                                                                                                                                                                                                                                                                                                                                                     int writemsg(fd, ptr, n)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        strcpy(msg, header);
                                                                                                                                                                                                                                                                                                     Sample call:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 nwrite, len;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      somcat(msg, ptr, n);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               register char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 register int
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               free(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          register int
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         n = 100;
```

} /* end writemsg */

```
sening - sends an external message 'msg' of size 'n'
to the specified IP destination <IPaddit, port>.

An header with the value of the size of the message, and a '~' as separator, is appended to the message. T 'vis header is to be processed by recringol.

The original message is not disturbed.
```

Sample call:

```
scrining (mag, n, IPaddr, port);

void scrining (mag, n, IPaddr, port)

char *mag;

int n;

char *IPaddr;

u_short port;
```

```
struct sockaddr_in target_addr,
struct hostent *phe;
struct iovec iov[2];
int sockfd, len;
u_short outpost;
char header[HEADERSIZE];
```

/* get the target UDP socket description */

treero((char*)&tanget_addr_sizeof(target_addr)); /* clear address structure */
target_addr_sin_family = AF_INET;
target_addr_sin_port = port;

if ((target_addr_sin_addr_s_addr = inet_addr(IPaddr)) == INADDR_NONE)

if ((target_addr_sin_addr_s_addr = inet_addr(IPaddr)) == INADDR_NONE)

if (the = gethostbyname(IPaddr))

if (the = gethostbyname(IPaddr))

bcopy(phe->h_addr_(char*)&target_addr_sin_addr, phe->h_length);

else {
 printf("sernnsg: cant get l%sl host entry\n", IPaddr);
 exit(1); }

```
/* request an arbitrary socket */
                                                                                             connect(sockfd, (smct sockaddr*) &target_addr, sizeof(target_addr));
                                                                                                                                                               /* assemble a scattered message including the msg size */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (writev(sockfd, &iov[0], 2) != (strlen(header) + n) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("senrusg: write error on socket \n");
/* set a connection to the destination */
                                                               sockfd = createUDP(&outport);
                                                                                                                                                                                                                                                                                                                                                                iov[0].iov_len = strlen(header);
                                                                                                                                                                                                   if (n > (len = strlen(msg)))
                                                                                                                                                                                                                                                                                                                                sprintf(header, "%d~", n);
                                                                                                                                                                                                                                                                                                     iov[0].iov_base = header;
                                                                                                                                                                                                                                                                                                                                                                                                  iov[1] iov base = msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                    iov[1]iov_len = n;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* send message */
                                   outport = htoms(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } /* end sentings */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   close(sockfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(1); }
                                                                                                                                                                                                                                         . . . <u>(cr.</u>
```

```
free(msgbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                return(mkm);
if ((msglen = recv(fd, buf, HEADERSIZE, MSG_PEEK)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            *msghead, *tmp, *msgbuf, buf[HEADERSIZE + 1];
                                                                                                                                                                                                                                 an extra NULL (to be used by the calling function).
                                                                                                                                                                    The function allocates the necessary space to build
                                                                                                                                                                                                                                                                   The calling function must free the allocated space,
                                                                                                  The message is atomically received, and is striped
                                                                                                                                                                                                   a non-Null terminated string "str', plus space for
                                                                                                                                                                                                                                                                                                                                  The function returns the message size, and -1 if
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* retrieve the header (the message is not removed) */
                                                                                                                                    of the header (as created by serunsg()).
                                       recmsg - reads an external message 'msg' at the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               len = recmsg(fd, &str);
                                                                                                                                                                                                                                                                                                    when it is no longer necessary.
                                                                                                                                                                                                                                                                                                                                                                   an invalid message is received.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if ((msglen = atoi(msghead)) == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             str[len] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              printf("recmsg: header error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                msglen, recvien, mien;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         buTHEADERSIZE] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                   Sample call sequence:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    char *st;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         msghead = strtok(buf,"~");
                                                                     specified IP socket.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                free(str);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 int recmsg(fd, str)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             register char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          return(0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 register int
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                char
```

```
if ((recvlen = recv(fd, msgbuf, msglen + HEADERSIZE, 0)) < 0) (
                                                                                                                                                                             msgbuf = CALLOC(msglen + HEADERSIZE + 1, char);
                                                                                                                                                                                                                                                                                                                                                               /* extract message info and discard header */
/* allocate space for entire message */
                                                                                                                                                    printf("recmsg: message error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  *str = CALLOC(mlen + 1, char);
                                                                                                                                                                                                                                                                                                    msgbuf[recvlen] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                          tmp = strtck(msgbuf,"~");
                                                                                                                                                                                                                                                                                                                                                                                                                         tmp = strick(NULL, "~");
                                                                                         /* get entire message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                        mlen = strlen(tmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* end recmsg */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strcpy(*str, tmp);
                                                                                                                                                                                                              free(msgbuf);
                                                                                                                                                                                                                                           return(-1); }
```

A SIMPLE APPLICATION and MAIN PROCESS

Simple Application	•••••	86
Main Process		88

- The application receives notice that the element has departed This is an example application, that creates an instance of the * GROUP MEMBERSHIP PROTOCOL - SIMPLE APPLICATION A mechanism for requesting the element shut-down is also membership protocol, and receives from it the most current group * by catching this signal (sent by mainproc) at function killelmnt() provided. This is accomplished with the following call: aplsocun, newsoc, childpid, clen, msglen; *aploath, *groupname, *sitelist, *msg; caller_addr, Fernando J. Pire 9 Mar 1993 KIIKO, SIGALRM); view, when this changes. sockaddr_un void main(argc,argv) #include "socutile." argv[]; #include "gmp.h" Last revision: void killelmnt(); Writen by: STIC char char Z.

switch(argc)(

DETERMINE INPUT ARGUMENTS (command line)

```
·
                                                                                                                                                                                                                                                                  printf("usage: simpleapp [groupname [sitelist ]]n");
                                                                                                                                                                                                                                                                                                                                                                                                                       OPEN LOCAL SOCKET (where group views are received)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ESTABLISH A SIGNAL HANDLER TO INTERCEPT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            THE ELEMENT FAIL URE SIGNAL FROM mainproc
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  **********************
                                                                                                         sitelist = (char*) NULL;
                    sitelist = (char*) NULL;
groupmame = "group0";
                                                                                     groupmame = argv[1];
                                                                                                                                                                            groupname = argv[1];
                                                                                                                                                                                                sitelist = argv{2};
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             apsocun = createUN(aphpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   apipath = UNIXSTR_TMPL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       signal(SIGALRM, killelmnt);
                                                                                                                                                                                                                                                                                        exit(-1);
                                                                                                                                 break;
                                                                                                                                                                                                                       break:
                                             Desk.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     listen(aplsocun, 5);
                                                                                                                                                                                                                                                                                                                                  } /* end switch */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          mktemp(aphath);
                                                                                                                                                                                                                                                                  default
                                                                                     case 2:
                                                                                                                                                                           case 3:
  case 1:
```

```
exech("mainproc", "mainproc", appath, groupmane, sielist, (char*)NULL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           while ( (newsoc = accept(aplsocum, (struct sockaddir*) & caller_addr, & clen)) >= 0) (
                                                                                                                                                                                                                                                                                                                                                                                                             EXECUTE LOOP TO RECEIVE UPDATED GROUP VIEWS
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* Send signal to mainproc and to itself, requesting element shut-down */
                                                                                                                                                                                                                                                                                                                                                                                                                                                printf("APPLICATION: received group view => #%sl\n", msg);
msg[msglcn] = NUIL; /*turn message into string */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         print("APPLICATION: read error\n");
                                                                                                                                                                                                                       /* child process */
                                                                                                                                                                                                                                                                                  printf("Error executing maintroch");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if(msglen = recrosg(newsoc, \&cmsg)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printi("APPLICATION: accept errorh");
                            EXECUTE GMP'S MAIN PROCESS
                                                             ********
                                                                                            if ((\text{childpid} = \text{fork}()) = -1)
                                                                                                                       printf("Can't fortkn");
                                                                                                                                                                                                                     if (childpid = 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                KII(0, SIGALRM);
                                                                                                                                                                                                                                                                                                                   cris(1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } /* end while */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 free(msg);
```

/* end simpleapp */

* CIROUP MEMBERSHIP PROTOCOL - MAIN PROCESS

- complete implementation of an element running the Membership Protocol This program waits for a child to cease execution (meanin This program is executed by the application, and spawns * that the element has or is to cease existence, and then releases all * resources to the operanting system.
- It also catches signals from the application requesting the element shut-down.
- *//create unix socket where Group Views are to be received//* char

Example of code used by the application to run this program:

societ

socpath;

- // Default path template // * socpeth = UNIXSTR_TMPL;
- // Get unique file name // * mixtemp(socpath);
 - * socfd = createUN(socpath); // Create unix socket //
 - - * listen(socfd,5);
- * //fork and execute mainproc//
- printf("Can't fork'n"); • if (childpid = fork() = -1)
- // child process // • else if (childrid == 0){
- exectp("mainproc", "mainproc", socpath, grouppathname, sitelist, (char*)NULL);
- printf("Error executing fronthn");
- cxit(1);}
- Notes: sitelist is a string with host names, separated by
- ='characters, Example: "sun2=sun10=aditya=taurus"
 - This list can be empty, in which case the local host Gruopname is optional. If no argument is provided
- it defaults to groupo.

"fpath, "bpath, "stmonpath, "streppath, "timerpath, "joinppath, *intmbrpath, *agrppath, *comppath, *gvmpath, *stmpath, /* these variables are common to 'mainproc' and 'killelmnt' */ "tompath, *apipath, *grouppathname; Fernando J. Pires 9 Mar 1993 #include "socutil.c" int main(argc,argv) *argv[]; #include "gmp.h" Last revision: void killelmnt(); argc; Writen by: .달

sfudp[MAXFD], soudp[MAXFD], sfun[MAXFD], sbun[MAXFD], ssmon[MAXFD], sagrp[MAXFD], scomp[MAXFD], sgvm[MAXFD], sstm[MAXFD], stpm[MAXFD], sfport[MAXPORT], styport[MAXPORT], my_name[MAXHOSTNAME + 1], sstrep[MAXFD], stimer[MAXFD], sjoinp[MAXFD], sintmbr[MAXFD] commitpid, frontpid, backpid, gympid, stmpid, tpmpid, timerpid, 'ip_addr, my_addr[MAXLMTSIZE+1], *groupname, *sitelist; fsocudp, fsocun, bsocudp, bsocun, smonfd, strepfd, timerfd, streppid, strnonpid, intrabrpid, agreepid, joinpid, returnpid; joinpfd, introbrfd, agrpfd, compfd, gymfd, stmfd, tpmfd, g

u_short front, bront;

struct hostent *hptr;

THE ELEMENT FAILURE SIGNAL FROM APPLICATION ESTABLISH A SIGNAL HANDLER TO INTERCEPT

signal(SIGALRM, killelmnt);

DETERMINE ADDRESS OF CURRENT ELEMENT

if (gethostname(my_name, MAXHOSTNAME) = 0) print("My name is %s\n", my_name);

printf("gethostname emor\n");

hptr->h_name, hptr->h_aliases[0]); printi("Success, found %s, also known as %s\n", if (hptr=gethostbyname(my_name))

print("Sorry host %s not found\n", my_name);

ip_addr = (char*) inet_neoa(*((struct in_addr*)(hpur->h_addr))); print("My IP address is %s/n", ip_addr);

DETERMINE INPUT ARGUMENTS (command line)

switch(argc){

groupmanne = "group0"; sitelist = my_name; apipath = argv[1];

itsk;

groupmame = argv[2]; stelist = my_name; aphpath = argv[1]; Case 3:

ŽŠ.

groupmame = argv[2]; aphath = argv[1]; sitchist = argv[3]; Presk; case 4:

printf("usage: mainproc aplsoc [groupname [sitelist]]\n"); exit(-1);

} /* end switch */

printf("MAINPROC: aplsoc = %s, proupname = %s, sitelist = %s\n", printf("MAINPROC: start execution\n"); aplpath, groupname, sitelist);

grouppathrame = CALLOC(strlen(, nouprame) + 6, char); strcpy(grouppathname, "/unp/");

strcat(grouppathrame, groupname),

******************** OPEN SOCKETS FOR ALL PROCESSES

* open FRONT part UDP socket (an Internet Datagram Socket) */ port = htons(0);

/* ask for an availabe port */ fsocudp = createUDP(&fport); sprintf(sfudp,"%d", fsocudp);

printf("FRONT: internet port => %dvn", ntohs(fport)); sprintf(sfport, "%d", fport);

printf("\n");

fpath = UNIXSTR_TMPL; /* Defau 't path template */ /* Get unique file name */ /* open a FRONT port Unix Domain Stream socket */ fsocun = createUN(fpath); listen(focum, 5); mktemp(fpath);

printf("FRONT: unix socket path => %sn", fpath); printf("\n");

sprintf(sfun,"%d", fsocun);

/* ask for an availabe port */ /* Get unique file name */ /* Default path template */ * open BACK port UDP socket (an Internet Datagram Socket) */ /* open a STATUS MONITOR Unix Domain Stream socket */ bpath = UNIXSTR_TMPL;/* Default path template */ /* Get unique file name */ printf("BACK: internet port => %dvn", ntchs(bport)); * open a BACK port Unix Domain Stream socket */ printf("BACK: unix socket path => %shn", bpath); smonpath = UNIXSTR_TMPL; becourb = createUDP(&bport); sprintf(sbudp, "%d", bsocudp); sprintf(spport, "%d", bport); sprintf(sbun, "%d", bsocum); bsocun = createUN(bpath) mktemp(stmompath); listen(beccun, 5); $\mathbf{bport} = \mathbf{htorus}(0);$ mktemp(bpath); print("n"); print("\n");

* open a STATUS MONITOR Unix Domain Stream socket */
smorpath = UNIXSTR_TMPL; /* Default path template */
mktemp(stmorupath); /* Get unique file name */
smonid = createUN(stmorupath);
lister(stmonid, 5);
sprintf(sstmon,"%d", stmonid);
printf("STATUS MONITOR: unix socket path => %s\n", smorupath);
printf("\n");

/* open a TIMER Unix Domain Stream socket */
innerpath = UNIXSTR_TMPL; /* Default path template */
inktemp(timerpath); /* Get unique file name */
timerfd = createUN(timerpath);

listen(timerfd, 5);
sprintf(stimer, "%d", timerfd);
printf("TIMER: unix socket path => %s\n", timerpath);
printf("\n");
/* open a JOIN PROCESSOR Unix Domain Stream socket */
joinprath = UNIXSTR_TMPL; /* Default path template */
mktempt/joinprath); /* Get unique file name */
joinpfd = createUN(joinppath);
listen(joinpfd, 5);
sprintf("JOIN PROCESSOR: unix socket path => %s\n", joinppath);
printf("\n");

" open a INTEGRATE MEMBER Unix Domain Stream socket */
introbrpath = UNIXSTR_TMPL; /* Default path template */
mklemp(introbrpath); /* Get unique file name */
introbrfd = createUN(introbrpath);
listen(introbrfd, 5);
sprintf(sintrobrfd, 5);
printf("INTEGRATE MEMBER: unix socket path => %s\n", introbrpath);
printf("\n");

/* open a COMMIT PROCESSOR Unix Domain Stream socket */
comppath = UNIXSTR_TMPL; /* Default path template */
mktemp(comppath); /* Get unique file name */
compfd = createUN(comppath);

if (listen(compfd,5) < 0) {
 printf("unainproc: Listen for commit socket failed ermo = %dvn", ermo);
 printf("\07\$"); }</pre>

sprintf(scomp,"%d", compfd); printf("COMMIT PROCESSOR: unix socket path => %sh", comppath); printf("\n");

/* open a AGREEMENT PROCESSOR Unix Domain Stream socket */
agrppath = UNIXSTR_TMPL; /* Default path template */
mktemp(agrppath); /* Get unique file name */

```
print("ACREEMENT PROCESSOR: unix socket path => %shn", agrppath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               print("STATUS TABLE MANAGER: unix socket path => %sh", stmpath);
                                                                                                                                                                                                                                                                                                                                                                                             print("GROUP VIEW MANAGER: unix socket path => %sh", gympath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* open a STATUS TABLE MANAGER Unix Domain Stream socket */
                                                                                                                                                                                              * open a GROUP VIEW MANAGER Unix Domain Stream socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * open a TOKEN POOL MANAGER Unix Domain Stream socket
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* Default path template */
                                                                                                                                                                                                                                                                /* Get unique file name */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* Get unique file name */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* Default path template */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* Get unique file name */
                                                                                                                                                                                                                                  /* Dyfault path template */
                                                                                                                                                                                                                                gympath = UNIXSTR_TMPL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               tompath = UNIXSTR_TMPL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                sumpath = UNIXSTR_IMPL;
agripfd = createUN(agrippath);
                                                                                                                                                                                                                                                                                                  gvmfd = createUN(gvmpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printd = createUN(tympath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  stmfd = createUN(stmpath);
                                                         sprintf(sagrp,"%d",agrpfd);
                                                                                                                                                                                                                                                                                                                                                             sprintf(sgvm, "%d" gvmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            sprintf(stpm, "%d", tpmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              sprintf(sstm, "%d", stmfd);
                                                                                                                                                                                                                                                                    mktemp(gympath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                mktemp(tpmpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    mictemp(strmpath);
                                   listen(aggpfd, 5);
                                                                                                                                                                                                                                                                                                                                    listen(gymfd, 5);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                listen(tomfd, 5);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  listen(stmfd, 5);
                                                                                                                                 print("\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               print("\n");
```

print("TOKEN POOL MANAGER: unix socket path => %sh", tpmpath);

print("n");

```
DETERMINE COMPLETE ADDRESS OF CURRENT ELEMENT
                                                                                                                                                                                                                                                              exectp("commit", "commit", scomp, my_addr, stmpath, gvmpath,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          ******************
                                                                                                                                                                                                                                                                                                                       *************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exectp("front", "front", sfudp, sfun, my_addr, streppath,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   tympath, intmbrpath, fpath, (char*) NULL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       joinppath, intmbrpath, (char*)NULL);
                                                                                                                                                                                                                                    printf("My element address is l%sl\n", my_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                       /* execute COMIMIT PROCESSOR process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("Error executing comp\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("Error executing fronthn");
                                                                                                                                                                                                                                                                                                                                                    CREATE ALL PROCESSES
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if ((commitpid = fork()) = -1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ((frontpid = fork()) = -1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* execute FRONT process */
                                                                                       strcpy(my addr, ip addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (commitpid == 0) {
                                                                                                                                                                                                        streat(my_addr, sbport);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("Can't forkyn");
                                                                                                                                              streat(my_addr, sfront);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("Can't forkyn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (frontpid = 0) (
                                                                                                                                                                          streat(my_addr, ";");
                                                                                                                   streat(my_addr, ";");
```

```
execlp("timer", "timer", stimer, stimorpath, (char*) NULL);
                                                                                                                                               /* child process */
                                                                                                                                                                                                          printf("Error executing timer\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if ((stmonyid = fork()) = -1)
                              if ((timexpid = fork()) = -1)
                                                                                                                                                                                                                                                                                                                                                      if ((streppid = fork()) = -1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if ((ioimpid = fork()) = -1)
/* execute TIMER process */
                                                        printf("Can't forth");
                                                                                                                                                                                                                                                                                                                                                                                    printf("Can't forkyn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("Can't forkyn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         printf("Can't forkyn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (stmompid = 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                               if (streppid = 0) {
                                                                                                                                                 if (timerpid = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (joinpid = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                exit(1); }
                                                                                                                                                                                                                                                                 exit(1); }
                                                                                                                                              exectp("back", "back", sburtp, sbun, my_addr, smonpath, agrippath, (char*)NULL);
                                                                                                                                                                                                                                                                                                                                                                                                                                           exectp("gvm", "gvm", sgvm, my_addr, aptrath, grouppathname, (char*) NULL);
                                                                                                                                                                                                        execlp("tpm", "tpm", stpm, (char*) NULL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* execute STATUS TABLE MANAGER process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exectp("stm", "stm", sstm, (char*) NULL);
                                                                                                                                                                                                                                                                                            /* execute GROUP VIEW MANAGER process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* execute TOKEN POOL MANAGER process */
                                                                                                                 /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                 /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* child process */
                                                                                                                                                                             printf("Error executing back\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           printf("Error executing gvm\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                printf("Error executing tpm/n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("Error executing stm\n");
                            if ((backpid = fork()) = -1)
                                                                                                                                                                                                                                                                                                                          if (gympid = fork()) = -1
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if ((tympid = fork()) = -1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if ((strupid = fork()) = -1)
/* execute BACK process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("Can't fork'n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                printf("Can't fork'n");
                                                       printf("Can't fork'n");
                                                                                                                                                                                                                                                                                                                                                      printf("Can't forth");
                                                                                                                 if (\mathbf{backpid} = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                  if (gympid = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (strmpid == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (trampid == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Cail(1); }
```

```
exectp("strep", "strep", sstrep, my_addr, tpmpath, fpath, (char*) NULL);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     execlp("joinp", "joinp", sjoinp, my_addr, stmpath, gvmpath, tpmpath,
execlp("stmon", "stmon", sstmon, my_addr, stmpath, gvmpath,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("Error er ecuting strnon\n");
printf("V7SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS);
                                                                                                                                                                                                                                                                                                                                                                                               agropath, introbroath, boath, fpath, grouppathname, sitelist,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          agropath, timerpath, bpath, (char*) NULL)
                                                                                                                                                                                                                                                                                 /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* child process */
                                                                                                                /* execute STATUS REPORTER process */
                                                                                                                                                                                                                                                                                                                                                         printf('Error executing strephn'');
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* execute STATUS MONITOR process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* execute JOIN PROCESSOR process */
```

```
exectp("agree", "agree", sagrp, my_addr, sunpath, gvmpath, tpmpath,
                                                                                                                                                                                                                                                       exectp("intmbr", "intmbr", sintmbr, my_addr, gvmpath, stmpath,
                                                 joinppath, comppath, fpath, (char*) NULL);
                                                                                                                                                                                                                                                                                 tympath, byath, (char*) NULL);
                                                                                                                                                                                                                                                                                                                                                                                                          /* execute ACREEMENT PROCESSOR process */
                                                                                                                                                                                                                                 /* child process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* child process */
                                                                                                                         /* execute INTEGRATE MEMBER process */
                                                                                                                                                                                                                                                                                                          print("Error executing introbha");
                          print("Error executing joinp\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          print("Error executing agrp\n");
                                                                                                                                                      if ( (intembrapid = fork()) = -1 )
                                                                                                                                                                                                                                                                                                                                                                                                                                      if (agrecapid = fork() = -1)
Chart) NULL);
                                                                                                                                                                               printf("Can't forkyn");
                                                                                                                                                                                                                                 if (intembrapid = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf('Can't fortk'n');
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (agreequid = 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* close all open files */
                                                                           sxii(1); )
                                                                                                                                                                                                                                                                                                                                                            cxif(1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exii(1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         close(intembrfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                close(bsocudp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       close(stmonfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      close(fsocudp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          close(timentd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 close(ioimpfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           close(compfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              close(bsccun);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 close(streptd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                close(agrpfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      close(fsocun);
```

```
printf(" has returned (pid = \%d)\n", returnpid);
if (returnpid == commitpid)
                                                                                                                                                                                                                                                                                                                                                                                                                                         if (retumpid == intmbrpid)
                                                                                                                                                                                                                                                                                                                                                                                                                   printf("Status Monitor");
                                                                                                                                                                                                                                                                                                                                                                                            if (retumpid == stmonpid)
                                                                                                                                                                                                                                                                                               if (returnpid — timerpid)
                                                                                                                                                                                                                                                                                                                                                                 printf("Status Reporter")
                                                                                                                                                                                                                                                                                                                                             if (returnpid == streppid)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("Integrate Mbr");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (returnpid == agreepid)
                                                  if (returnpid == frontpid)
                                                                                                                                              if (returnpid == gympid)
                                                                                              if (returnpid == backpid)
                                                                                                                                                                                                                                              if (returnpid — tympid)
                                                                                                                                                                                              if (returnpid == stmpid)
                         printf("Commit");
                                                                      printf("FRONT");
                                                                                                                    printf("BACK");
                                                                                                                                                                                                                                                                                                                   printf("Timea");
                                                                                                                                                                     printf("GVM");
                                                                                                                                                                                                                    printf("STM");
                                                                                                                                                                                                                                                                    printf("TPM");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("Agree");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      sleep(120);
```

printf("MAIN PK CCESS: ");

retumpid = wait (int*) NULL);

/* wait until one process exits */

close(gvmfd);

close(stmfd); close(tpmfd); printf("07MAIN PROCESS: ");

```
SIGNAL HANDLER THAT CATCHES ELEMENT DEPARTURE
                                                                                                                                                                                                                                              printf("MAINPROC: application has requested shut-down\n");
               /* Signal the application that the element has ceased existence */
                                                                                                                                                                                                                                                                                                                                                                                                  /* Remove Unix Domain socket links */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          remove(grouppathname);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ree(grouppathname);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               unlink(intmbrpath);
                                                                                           } /* end mainproc */
                                         kill(0, SIGALRM);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               unlink(stmompath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              unlink(timerpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 unlink(comppath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      unlink(joinppath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    unlink(streppath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       unlink(agrppath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          unlink(gympath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            unlink(tompath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  unlink(stmpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ınlink(aplpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                     unlink(breath);
                                                                                                                                                                                                                                                                         void killelmnt()
                                                                                                                                                                                                                                                                                                                                                                                                                              unlink(fpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    print(" has returned (pid = %d)\n", returnpid);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* Remove Unix Domain socket links */
if (returnpid == commitpid)
                                                                                                                                                                                                                                                                                                                                                                              printf("Status Reporter");
                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (returneyed == introducid)
                                                                                                                                                                                                                                                                                                                                                                                                                               printf("Status Monitor");
                                                                                                                                                                                                                                                                                                                                                                                                       if (returnpid == stmornpid)
                                                                                                                                                                                                                                                                                                     if (returnpid == timespid)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (returnpid == agreepid)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("Integrate Mbr");
                                                                                                                                                                                                                                                                                                                                                      if (returnpid — streppid)
                                                                                                                                                 if (returnpid == gympid)
                                               if (returnoid == frontpid)
                                                                                                if (returnized == backpid)
                                                                                                                                                                                                                                                      if (returnpid == tympid)
                                                                                                                                                                                                   if (returnpid == stmpid)
                                                                       print("FRONT");
                        print("Commit");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            unlink(stmonpath);
                                                                                                                        printf("BACK");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             unlink(tin capath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       unlink(joimppath);
                                                                                                                                                                         print("GVM");
                                                                                                                                                                                                                                                                                                                               print("Timer");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      unlink(str-sppath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("Agree");
                                                                                                                                                                                                                                                                             print("TPM");
                                                                                                                                                                                                                            printf("STM");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       unlink(bpath);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                unlink(foath):
```

} /* end killelmnt */

unlimk(introbroath);

unlink(comppath);

unlink(gympath);

unlink(stmpath); unlink(spripath); unlink(apipath);

unlink(agrppath);

FIFO CHANNEL

FIFO Channel Process Dependencies)6
Front Process Specification	7
Back Process Specification	8
Front) 9
Back 10)2

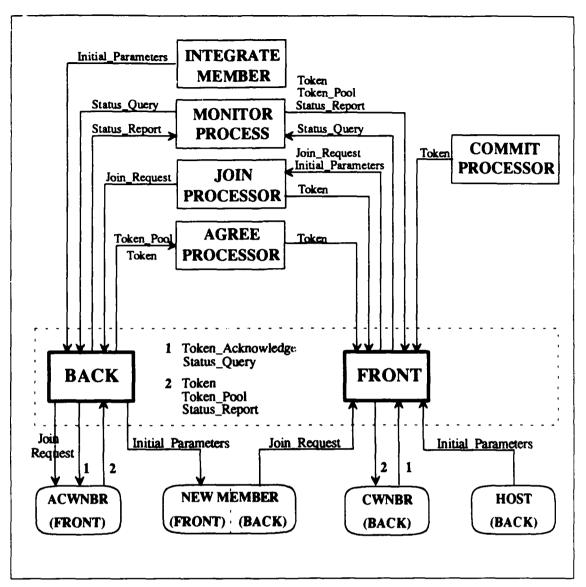


Figure A1 FIFO Channel - Process Dependencies

```
FIFO Channel - FRONT Process
 1 Wait for a channel ready to read
2 if (external channel ready)
3
      if (Status Query)
4
         send Status Query to MonitorProcess
5
     else if (JoinRequest)
6
         send JoinRequest to JoinProcessor
7
     else if (InitialParameters)
         send InitialParameters to JoinProcessor
8
9
     else if (TokenAck)
10
         if (Received Serial Number = Expected serial number)
           remove Head of Queue
11
12
           decrement Queue Counter
13
         end
14
     end
15 else /* internal channel ready */
16
      if (Token)
17
         change Token to external format /* add external header */
18
         insert Token in queue
19
         increment Serial Number
20
         increment Queue_Counter
21
      else if (TokenPool)
22
         discard all messages in queue
23
         change TokenPool to external format /* add external header */
         insert TokenPool in queue
24
25
         increment Serial Number
26
         increment Queue Counter
27
      else if (StatusReport)
23
          update cwnbr
29
         send StatusReport to cwnbr
30
       end
31 end
32 if (Queue_Counter > 0)
33
       send Head of Queue to cwnbr
       set Expected serial number = Head of Queue serial number
34
35 end
```

Figure A2 FIFO Channel - Front Process

```
FIFO Channel - BACK process
  Wait for a channel ready to ready
   if (internal channel ready)
     if (Status Query)
        update acwnbr
        send Status Query
    else if (Initial Parameters)
        update acwnbr
8
        send Initial Parameters
9
     else if (Join Request)
10
        send Join Request
11
     end
12 else /* external channel ready */
13
     if (message originator = acwnbr)
14
        if (Status Report)
15
           send Status Report to MONITOR_PROCESS
16
       else if (Token)
17
           if (Serial Number = Expected_Serial_Number - 1)
18
             send Token Ack /* to acwnbr */
19
           end
20
           if (Serial_Number = Expected_Serial_Number)
21
             send Token to AgreeProcessor
22
             send Token Ack /* to acwnbr */
23
             increment Expected_Serial_Number
24
          end /* out of order messages are discarded */
25
       else if (Token Pool) /* Token_Pool is always accepted */
26
           send Token Pool to AgreeProcessor
27
           send Token Ack /* to acwnbr */
28
          set Expected_Serial_Number = Serial_Number + 1
29
       end
30
     end
31 end
```

Figure A3 FIFO Channel - Back Process

```
if ((newsoc = accept(sockun,(struct sockaddr*)&uncaller_addr, &clen)) < 0 ) {</pre>
                           printf("Usage: front sockudp sockun my_addr strep joinp intmbr\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * Wait for a connection from a client process, either at
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (FD_ISSET(sockun, &fdread)) { /* Unix socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (select(32, &fdread, NULL, NULL, NULL) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if((msglen=readmsg(newsoc,&msg,"#")) < 0) {
                                                                                                                                                                    cwnbr = CALLOC(strlen(my_addr) + 1,char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("FRONT unix: accept error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("FRONT PORT: select arroryn"):
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf(" FRONT unix: read error\n");
                                                                                                                                          /* Initialize cwnbr as my_addr */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           clen = sizeof(uncaller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                           * the Internet or Unix socket.
                                                                                                                                                                                                                                                                                                                FD_SET(sockudp, &fdread);
                                                                                                                                                                                                                                                                                                                                            FD_SET(sockum, &fdread);
                                                                                                                                                                                                   strcpy(cwnbr,my_addr);
                                                                                                                                                                                                                                                                                   FD_ZERO(&fdread);
                                                                                                                                                                                                                                                          while(TRUE) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                exit(1); )
*cwnbr, *topmsg, *msg, *cxtmsg, *umpmsg;
*my_addr, *strep, *joinp, *intmbr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      queue_counter=0, expectsmbr=1, smbr=1;
                                                                                   This program is executed by mainproc.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               *head = NULL, *tail = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         sockaddr_un uncaller_addr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                sockardp, sockarn, newsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           msgtype, clen, msglen;
                                                                                                                                                                      * Writen by: Fernando J. Pires
                                                                                                                                                                                                 David Pezdirtz
                                                                                                                                                                                                                                                        * Last revision: 11 May 1993
                             * FRONT PORT MANAGER
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                sockadp = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             sockum = atoi(argv[2]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       my_addr = argv[3];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         intrindr = argv[6];
                                                                                                                                                                                                                                                                                                                                                                                                 #include "gmputil.c"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  strep = argv[4];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            joinp = argv(5);
                                                                                                                                                                                                                                                                                                                                                                                                                              Hinclude "fifoutil.c"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        int main(argc,argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      fdread;
                                                                                                                                                                                                                                                                                                                                                                     #include "gmp.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (argc = 7) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             char *argv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                int argc;
```

```
print("FRONT: invalid message type !%dbn",msgtype);
print("U/SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS");
msg[msglen]=NULL; /*urn message into string */
                                                                                                                                                                                                                                                                                                                                         extransg = int_2_ext(msg, srnbr, my_addr);
                                                   /* Determine which message was received */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               extrnsg = int_2_ext(msg, 0, my_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        send_msg_back(extrnsg, cwnbr);
                                                                                                                                                                                                                                                                                                                                                                  enqueue(&head, &tail, extmsg);
                                                                                                                                                                                                        flush_queue(&head, &tail);
                                                                                                       msgtype = in_msg_type(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        cwntr = get_target(msg);
                                                                                                                                                                                                                                   queue_counter = 0;
                                                                                                                                                                               Case EXTIKNIPOOL:
                                                                                                                                                                                                                                                                                                               case TOKENTOKN:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        queue_counter++;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  CASE STATUSRPT:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* end switch */
                                                                                                                                                        switch (magtype) {
                                                                                                                                                                                                                                                                                                                                                                                                                        free(extrusg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(cwmbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          free(extrusg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                  STIPLE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 czii(1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       default
```

close(newsoc);

free(msg);

```
msg[msglen]=NULL; /*turn message into string */
/* end if then FD_ISSET(sockun, &fdread) */
                                                                                                                                                                                                                                                                                     /* Determines which message was received */
                                                                                                     if ( (msglen=recmsg(sockudp, \&msg)) < 0) {
                                                                                                                              printf("FRONT internet: receive error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (get_sr_nbr(msg) == expectsmbr) {
                                                                                                                                                                                                                                                                                                               msgtype = ext_msg_type(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        send_msg_in(msg, joinp);
                                                                                                                                                                                                                                                                                                                                                                                                                                          send_msg_in(msg, strep);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       dequeue(&head, &tail);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (queue_counter > 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      queue_counter-;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 case TOKENACKN:
                                                                                                                                                                                                                                                                                                                                                                                                                 case STATUSORY:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              case INITPARAM:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     case JOINREQST:
                                                                                                                                                                                                                                                                                                                                                                                          switch (msgtype) {
                                                                                                                                                                               exit(1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Presk:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        break;
                                                    else (
```

default: print("FRONT: invalid message type 1%divn", msgtype); print("V7\$\$\$\$\$\$\$\$\$\$\$\"); exit(1);

} /* end switch */

free(msg);

} /* end else if (FD_ISSET(sockudp, &fdread) */

if (queue_counter > 0) {
 get_queue_head(head, &tmpmsg);

topmsg = CALLOC (strlen(unpmsg) + 1, char); strcpy(topmsg.impmsg);

send_msg_back(topmsg, cwnbr); cxpectsmbr = get_sr_nbr(topmsg);

free(topmsg);

} /* and while TRUE */

} /* and FRONT */

if ((newsoc = accept(sockun, (struct sockaddr*) & uncaller_addr, & clean)) < 0) { printf("Usage: BACK sockudp sockun my_addr stmon agrphn"); * Wait for a connection from a client process, either at if (FD_ISSET(sockum, &fdread)) { /* Unix socket */ if (select(32, &fdread, NULL, NULL, NULL) < 0) { acwmbr = CALLOC(strlen(my_addr) + 1,char); printf("BACK unix: accept error\n"); printf("BACK PORT: select error'n"); /* initialize last token pool to dummy */ /* Initialize acwnbr to be my_addr */ clen = sizeof(uncaller_addr) * the Internet or Unix socket. FD_SET(sockudp, &fdread); FD_SET(sockun, &fdread); last_tp=CALLOC(6, char); strcpy(last_tp, "dummy"); strcpy(acwnbr, my_addr); FD ZERO(&fdread); exig(1); } while(TRUE)(************* *acwnbr, *target, *originator, *extmsg, *last_p; This program is executed by mainproc. expects mtr = 1, smbr, last smbr = 0; *stmcn, *agrp, *my_addr, *msg; uncaller addr. sockudp, sockum, newsoc; megtype, clen, meglen; Writen by: Fernando J. Pires * Last revision: 26 Jul 1993 David Pezdintz *BACK PORT MANAGER sockardp = atoi(argv[1]); soctoun = atoi(argv[2]);add_oniginator(); main(argc,argv) sockaddr un $my_addr = argv(3);$ stmon = argv[4]; $\operatorname{agn} = \operatorname{argv}(5);$ Hinchude "graputil.c." Hinclude "fifoutile" facad; Hinchade "gmp.h" if(argc = 0)

M

SPIECE Sper Char

```
msg[msgkm] = NULL; /*urm message into string */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* check for retransmit of previous token */
                                                                                                                                                                                                                                                                                                                Determines which message was received */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               send_ack(msg, my_addr, acwnbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        send_ack(msg, my_addr, acwnbr);
if ( (msglen=recmsg(sockudp,\&msg)) < 0) {
                         printf("BACK internet: receive error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* check for expected message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      send_msg_in(msg, agrp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                 send_msg_in(msg, stmon);
                                                                                                                                                                                                                                                              if (stremp(acwnbr,originator) = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          lastsmbr = expectsmbr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if(expectsmbr == smbr) {
                                                                                                                                                                                                                                   /* accept msg only from acwnbr */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    smbr = get_sr_nbr(msg);
                                                                                                                                                                                                                                                                                                                                           msgsype = ext_msg_type(msg);
                                                                                                                                                                                  originator = get_originator(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if( smbr == lastsmbr){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 expectsmbr++;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       case TOKENTOKN:
                                                                                                                                                                                                                                                                                                                                                                                                                   case STATUSRPT:
                                                                                                                                                                                                                                                                                                                                                                                               switch (msgtype) |
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            break;
                                                                              exit(1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              print("BACK: received invalid message type\n");
```

extrasg = int_2_ext(msg, 0, my_addr);

target = get_target(msg);

case JOINREQST:

acwnbr = get_target(msg);

free(acwribr);

case STATUSQRY: Case INTIPARAM:

switch (msgtype) {

send_msg_front(extmsg, target);

free(extrusg);

break;

default

free(target);

} /* end if (FD_ISSET(sockun, &ddread)) */

ese |

close(newsoc);

free(msg);

Gif(1);

msg[msglen] = NULL; /*turn message into string */

if((msglen=recmsg(newsoc, &msg)) < 0) {

printf(" BACK unix: read error\n");

exii(1);]

/* Determine which message was received */

msgtype = in_msg_type(msg)

MONITOR PROCESS

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Timer	113

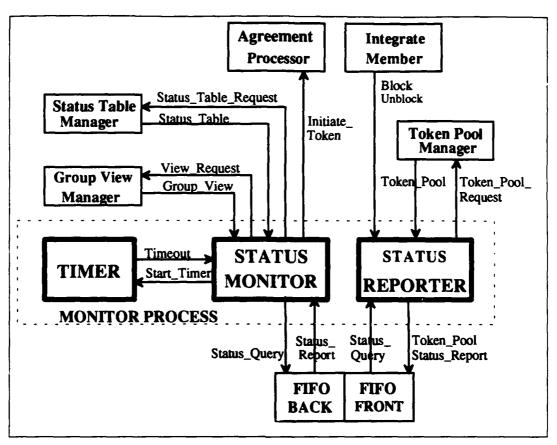


Figure A4 Monitor Process - Internal Structure and Dependencies

```
ReportStatus process at p.
1
     if (not blocked by IntegrateMember)
2
        if (querying member \in GV_{p_i} or has joinagree status)
3
           p_{mon} = querying member
4
           send status to p<sub>mon</sub>
5
           if (previous querying member = p_{max})
             send TokenPool(p<sub>i</sub>) to p<sub>mon</sub>
6
7
           end
8
        end
9
     end
  end ReportStatus
```

Figure A5 Reporting of Status

```
printi("VUsage: StatusReporter soc myaddr stmsoc gymsoc agrsoc timsoc backsockn").
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              printf("\StatusMonitor: acwnbr computation failed.\n");
                                                                                                                                                                                                                                                                                               * Send a query, start a timer, wait for a response or a timeout.
                                                                                                                                                                                                                                                                                                                                                                                                                 if (GetAcwnbr(acwnbr, myaddr, stmsoc, gvmsoc) != 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /*end of message delimiter*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("\Status\Monitor: query send failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /*originator of report*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (writemsg(backfd, query, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /*target of report*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              query = CALLOC(QUERYLEN + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /*msg type*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           *separator*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /*separator*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               backfd = connectUN(backsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(query, "statusqry");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /*assemble a status query*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     msglen = strlen(query);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               streat(query, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       strcat(query, acwnbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         streat(query, "\n");
                                                                                      backsoc = argv(7);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       *send the query*/
gvmsoc = argv[4];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 streat(query, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            streat(query, "#");
                            agrsoc = argv[5];
                                                           timsoc = argv[6];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        close(backfd);
                                                                                                                                                                                                                                                                                                                                                          while (TRUE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    free(query);
                                                                                                                                                                                                        exit(-1); }
/***********************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             *hacksoc, *strnsoc, *gymsoc, *agrsoc, *timsoc, *myaddr, acwnbr[MAXLMTSIZE+1], *quezy, starttimer[TIMERMSG+1], *msgheader,
                                                                                                                      for BACK, status table manager, group view manager, agreement
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *originator, *timesmsgtype, msg2times[TTMERMSG+1], *buf;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * Get socket file descriptors from command line argument. myaddr is in
                                                                                         * Description: Uses one Unix domain socket. Receives socket names
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                soc, newsoc, clen, msglen, backfd, timfd, msgtype;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       print("VStatusMonitor Process: start execution.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          * the defined messageformat (ipaddr; front; back)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                caller addr.
                                                           * Algorithm: Fig. 3 of the group paper
                                                                                                                                                    process, and timer process.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *msg, *msgfromtimer;
                                                                                                                                                                                                            * Written by: Shridhar Shukla
                                                                                                                                                                                                                                         10 Mar. 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                soc = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               myaddr = argv[2];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strnsoc = argv[3];
                                                                                                                                                                                                                                                                                                                                                                                                                          world SendTlan2Agr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 struct sockaddr_un
                                                                                                                                                                                                                                                                                                                                  #include "graputil.c"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             *argv[];
                                   * Spans/Monitor:
                                                                                                                                                                                                                                                                                                                                                                                              in GetAcwnbr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (arrgc == 8){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      main(argc,argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    200 E
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                룡
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          直
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Ĕ
```

```
msgtype = TTMEOUT __: /* only tpad timeout possible type not checked */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (strcmp(msgheader, "statusrpt") == 0) { /*also identify sender */
                                                                                                                                                                                                                                                                                                                               case STATUSRPT: /* send start gry timer and wait until its time */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        case TIMEOUT ...: /* send initiate agreement msg and block */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("\StatusMonitor: sts rpt not from present acwnbr.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (writemsg(timfd, msg2timer, msglen) < msglen) |
                                                                                                                                                                                                                                                                                                 printf("\StatusMonitor: sts rpt parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("\StatusMonitor: qry timr strt failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        SendTkn2Agr(agrsoc, "failagree", acwnbr);
                                                                                                                                                                                                                                                                     if (getfromlist(msg, &originator, 3) = 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* end if stremp(msgheader, "statustpt") */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * to send the next query
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(msg2timer, "starttimr\ntqry#");
                                                                                                                                                                                                                                                                                                                                                                                                                                      if ( strcmp(acwnbr, originator) != 0) {
if (stremp(msgheader, "timeout_") == 0){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* assemble start timer msg */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          timfd = connectUN(timsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            msglen = strlen(msg2timex);
                                                                                                                                                                                               msgtype = STATUSRPT;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                    exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          switch (msgtype) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     removelist(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         free(but);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if ((newsoc = accept(soc, (struct sockaddt*) &caller_addt, &clen)) < 0){
```

* Read either a response to the query or timeout message*/

cxii(-1);

if ((msglen=readmsg(newsoc, &but,"#")) < 0) {

print("vStatusMonitor unix: accept error.\n");

Accept status report or timeout from back */

clen = sizeof(caller addr);

printf("\StatusMonitor. start timer failed.\n"); if (writemsg(timfd, starttimer, msglen) < msglen) {

cxii(-1); }

close(timfd);

strcpy(startimer, "startim\nquad#");

send start timer message/

timfd = connectUN(timsoc);

msglen = strlen(starttimer);

print("\StatusMonitor: unix PORT read error.\n");

print("\Status\Monitor: msgtype parsing failed.\n");

if (getfromlist(msg, &msgheader, 1) = 0) {

"determine the message type. "/

buf[msglen] = NULL;

close(newsoc);

cai(-1);)

msg = str2list(buf, "\n #");

```
if ( (newsoc = accept(soc, (struct sockaddt*) & caller_addt, & clen)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("\Status\Monitor: accept from timer failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("\StatusMonitor: timr msg parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (getfromlist(msgfromtimer, &timermsgtype, 2) == 0)
                                                                                                                                                                               printf("\Status\Monitor: timer read failed\\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("\StatusMonitor: timer func failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("Status Monitor: received invalid msg type\n");
                                                                                                                                                  if ( (msglen = readmsg(newsoc, \&buf,"#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* end if (stremp(timermsgtype, "tqry") */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (stremp(timesmsgtype, "tqry") != 0) {
                                                                                                                                                                                                                                                                                                                                                                                                 msgfromtimer = str2list(buf, "\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 removelist(msgfromtimer);
                                                                                                                                                                                                                                                                                                        buf[msglen] = NULL;
                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); }
                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                       close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* end while TRUE */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /* end switch */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                free(buf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  exit(-1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* end main */
                                                                                                                                                    if ( (newsoc = accept(soc, (struct sockaddr*) & caller_addr, & clen)) < 0 ) {

    The following discards a trad msg from timer that is delayed.

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * A two-level if is used instead of a while because there is
```

if (getfromlisa(msgfromtimer, &timermsgtype, 2) = 0) print("\Status\Monitor: timr msg parsing failed.\n");

cai(-1);)

msgfromtimer = str2list(buf, "\n#");

bufmsglen] = NULL; close(newsoc);

cxii(-1);)

* exactly one tpad to be discarded if any.

if (stremp(timesmagaype, "topy") !=0) {

removelist(msgfromtimer);

 $clen = sizeof(caller_addr);$

print("VSBansMonitor: accept from timer failed.\n");

Accept query expiration msg from timer */

close(timfd);

clen = sizeof(caller_addr);

if ((msglen = readmsg(newsoc, &buf,"#")) < 0) { print("\StatusMonitor: timer read failed.\n");

```
if ( (newsoc = accept(soc, (struct sockaddr*) & caller_addr, & clen)) < 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("NUsage: StatusReporter soc myaddr tomsoc frontsoc'n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("VStatusReporter: unix PORT read error:\n");
                                                                                                                                      strepy(prev_mon, myaddr); /* initially, one monitors self */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("\Status\Reporter: query parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         printf("StatusReporter unix: accept error.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if ((msglen=readmsg(newsoc,&buf,"#")) < 0 ) {</pre>
                                                                                                                                                                                                                                           * Wait for a query to appear and respond to it.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            query_components = str2list(querydata, "");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (getfromlist(query, &querydata, 2) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* Accept status query from front */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      query = str2list(buf, "\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    buf[msglen]=NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* Read message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    cxif(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exit(-1); }
                                                                                                                                                                                                                                                                                                                                             while(TRUE)(
                                                                      exit(-1); }
***************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *frontsoc, *tomsoc, *myaldr, mon[MAXI_MTSIZE], prev_mon[MAXI_MTSIZE],
                                                                                                   * Description: Uses one Unix domain socket. Receives FRONT and token pool manager
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         "querydata, "buf, "target, 'originator, thpreq[NODATAMSG+1],
                                                                                                                                    socket names along with addr of the member it belongs to.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* Get socket file descriptors from command line argument */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("vSrausReporter Process: start execution\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           soc, newsoc, clen, msglen, frontid, tpmfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  "query, "query_components, "list;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    caller addr,
                                                                * Algorithm: Fig. 4 of the grap paper
                                                                                                                                                                       * Written by: Shridhar Shukla
                                                                                                                                                                                                        David Pezdirtz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          soc = atoi(argv[1]);
                                                                                                                                                                                                                                                                           27 Jul 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             myaddr = argv[2];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            tomsoc = argv(3);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               frontsoc = argv(4);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                struct sockaddr_un
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                msg. *pool;
                                                                                                                                                                                                                                                                                                                                                                                                                 Hinchude "gompunile"
```

2005; *2003v[];

Sp

if (argc = 5){

Se

main(argc,argv)

* Date

* SenusReporter

```
msg = CALLOC(9 + strlen(myaddr) + strlen(pool) + 3 + 1, char);
                              strepy(prev_mon, mon); /* update the previous monitor */
if (stremp(mon, prev_mon) != 0) { /* if there is a new monitor */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("\Status\Reporter: token pool parsing failed.\n");
                                                                                                                                                                                                                                                                                                         printf("\StatusReporter. token pool request failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /*open connection*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                printf("\Status\Reporter: token pool read failed.\n");
                                                                                                                                                                                                                                                                          if (writemsg(tpmfd, tkpreq, msglen) < msglen ){
                                                                                                                                                                                                                                                                                                                                                                                                                                               if ( (msglen=readmsg(\psinnfd,&buf,"#")) < 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * create the external token pool message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /*send the token pool to monitor via front*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (getfromlist(list, &pool, 2) = 0){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           frontfd = connectUN(frontsoc);
                                                                                                                                                                                                        pmfd = connectUN(tpmsoc);
                                                                                                                                        strcpy(tkpreq, "tokpreqst#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    strcpy(msg, "extkmpooln");
                                                                                                                                                                       msglen = strlen(tkpreq);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            list = str2list(buf,"\r\#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        buf[msglen] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msglen = strlen(msg);
                                                                                                     /*get the token pool*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        strcat(msg, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strcat(msg, pool);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       streat(msg, "\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           streat(msg, "#");
                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        CXIE(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         close(tamtd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               *assemble a status report message in the same place as the query received*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (writemsg(frontfd, buf, msglen) < msglen) {    /*write all the bytes*/
                                   print("\SausReporter: query component parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                 printf("\StatusReporter. query component parsing failed.\n");
                                                                                                                                                                                                              printf("\StatusReporter. target of query is not me.\n");
```

free(but); /*storage acquired on read of query returned*/

frontid = connectUN(frontsoc); /*open connection*/

"send the status report out"/

msglen = strlen(but);

/*end of message delimiter*/ /*originator of report*/

/"target of report"/

streat(buf, mon);

streat(buf, " ");

streat(buf, "vn");

/*separator*/

strcat(buf, myaddr);

strcat(buf, "#");

/*separator*/

strepy(out, "statusept"); /*msg type*/

removelist(query_components);

stropy(mon, oniginator);

Sij(-1);

removelist(query);

print("\StatusReporter. report send failed.\n");

Caid(-1);)

close(frontfd);

if (getfromlist(query_components, & originator, 2) == 0){

cxif(-1); }

if (getfromlist(quezy_components, &target, 1) = 0)(

if (strcmp(myaddr, target) != 0)(

cxii(-1);)

cxis(-1);}

close(frontid);

removelist(list);

free(buf); free(msg);

} /* end if (stremp(mon, prev_mon) != 0) */

close(newsoc);

| /* end while(TRUE) */

| /* and StatusReporter */

```
if ( (newsoc = accept(soc, (struct sockaddr*) & caller_addr, & clen)) < 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (stremp(timermsgtype, "tpad") = 0) { /* start tpad timer */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   else { printf("\Timer: start timer msg not for tpad.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("ATimer: unix PORT read error.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                printf("VTimer: msgtype parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (getfromlist(msglist, &timermsgrype, 2) = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                if ((msglen=readmsg(newsoc,&buf,"#")) < 0) {
                                                                                                                                                                                                                                                                                                                                printf("\Timer: unix accept error.\n");
                                                            /* Make the following read blocking */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 countval = GetNextTpad(); )
                                                                                                                              ioctl(soc, FIONBIO, (char *) &con);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* determine the message type. */
                                                                                                                                                                                                  /* Accept a start timer msg. */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  msglist = str2list(buf, "\n#");
                                                                                                                                                                                                                                clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  buf[msglen]=NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     removelist(msglist);
                                                                                              on = BLOCKING
                                                                                                                                                                                                                                                                                                                                                                                                  exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exif(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    close(newsoc);
while(TRUE) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 free(buf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  <del>|</del>
* Description: Uses one NONBLOCKING Unix domain socket. Receives socket name
                                                                                                                                                              the timer, the nonblocking Unix domain socket is checked for
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  *smsoc, *timesmsgtype, *buf, timeoutmsg[TIMERMSG+1];
                                                                  * Algorithm: when a trad msg from Status Monitor (sm, for short) is
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    soc, newsoc, clen, msglen, smfd, on, county: ', countfortqry;
                                                                                                                                                                                                                                                                    GetNextTqry. A tqry timeout msg is sent to sm. If the tpad
                                                                                                  received, a timer for an interval equal to the value returned
                                                                                                                                  by GetNextTpad is started. In between successive ticks of
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 a topy msg from sm. If one is received before the timer
                                                                                                                                                                                                                                runs out, the timer value is reset to a value returned by
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Cet socket file descriptors from command line argument. */
                                                                                                                                                                                                                                                                                                    imer runs out, a tpad timeout msg is sent.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       caller_addr,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("AUsage: timer soc smsoch");
                                                                                                                                                                                                                                                                                                                                                                                                                                  * Written by: Shridhar Shukla
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  22 Feb. 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     soc = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                          for sm.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       smsoc = argv(2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     struct sockaddr_un
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *msglist;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  #include "gmputil.c"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    in GetNex(Tpad();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    in CetNex(Tqry();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *argv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        main(argc,argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (arrgc = 3) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     exif(-1); }
                                  * Timer:
```

```
printf("VTimer: tqry expected, something else rcvd.\n");
                             printf("VTimer: msgtype for tqry parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (countfortary == TRUE) ( /* timeout msg on tary to be sent */
if (getfromlist(msglist, &timermsgtype, 2) ==0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (writemsg(smfd, timeoutmsg, msglen) < msglen)
                                                                                                                                                            if (stremp(timesmsgtype, "tqry") !=0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("VTimer: Timeout msg send failed.\n")
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 strcpy(timeoutmsg, "timeout_\ntqry#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               strcpy(timeoutmsg, "timeout_vnpad#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   else /* timeout msg on tpad to be sent */
                                                                                                                                                                                                                                                                                                                       countval = GetNextTqry();
                                                                                                                                                                                                                                                                                                                                                          countfortqry = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* end else newsoc */
                                                                                                                                                                                                                                                                                                                                                                                                                      removelist(msglist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* end while CountDown */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* end if ~countfortqry */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 msglen = strlen(timecoutmsg);
                                                                                             exit(-1); }
                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 smid = connectUN(smsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                          free(buf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } /* end while true */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         } /* end Timer */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            close(smfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if ((camo = EWOULDBLOCK) II (camo = EINPROCRESS)) {
                                                                                                                           icct(soc, FIONBIO, (char *) &cn); /* CHECK: is the cast necessary? */
                                                                                                                                                                                                                     if (countientay = FALSE) ( /* need to check for msg */
                                                                                                                                                                                     while (CountDown(&countval, COUNT_DOWN_STEP) > 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("VTimer: unix PORT read error.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if ((msglen=readmsg(newsoc,&but,"#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            # msg was read - check its type to be tqry */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      else { printf("\Timer unix accept error.\n");
                                                                                                                                                                                                                                                                                                                        if ((newsoc = accept(soc, (struct sockaddr*)
                                                                                                                                                                                                                                                                                                                                                        & caller_addr, & clen) = -1) 
                                                                                                                                                                                                                                                                                                                                                                                                                                                        ; /* no connections present */ }
                                                            /* Make the following read nonblocking */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    else ( /* a connection is present */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* end then newsoc = accept */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       msglist = str2list(buf, "\n#");
                                                                                                                                                                                                                                                            clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              buf[msglen]=NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  cxii(-1); )
```

M = NONBLOCKING:

countionary = FALSE;

Ĭ. GetNextTqry(): The count down loop in Timer.c does not attempt to read the socket while it is counting down from the value returned by next = TQRY_INTERVAL; rehum(next); } /* end GetNextTqry */ this function. in CelNex(Topy) next; .법

GetNextTpad(): The count down loop in Timer.c attempts to reads the socket while it is counting down from the value returned by this function. If a msg is read, the down counter is initialized to the value returned by GetNextTqry().

int GetNextTpad()

{
 int next;

 next = TPAD_INTERVAL;

return(next);

} /* end GetNextTpad */

AGREEMENT PROCESSOR

Agreement Processor - Process Dependencies	117
AgreeProcessor Specification	118
Determination of Token Originator's Failure	119
Processing Agree Tokens	120
Agree.c	121

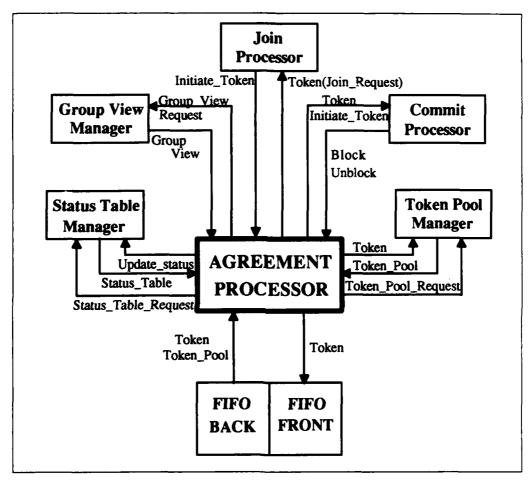


Figure A6 Agreement Processor - Process Dependencies

```
AgreeProcessor for agree_{p_i}(p_k) at p_i
1 if (not blocked by CommitProcessor)
2
     if (initiate agreement message received) /* p_i = p_i */
3
        add agree_{p_i}(p_k) to TokenPool(p_i)
4
         ST_{p_i}(p_i) \leftarrow joinagreed or failagreed
5
        send agree<sub>pi</sub>(p<sub>k</sub>) to cwnbr(p<sub>i</sub>)
6
        send acknowledgment to calling process
7
      else /* a token or external token pool is received */
8
         if (ExtTokenPool)
9
            for \foralltokens \in ExtTokenPool
                if (token \in TokenPool(p_i))
10
                   if (originator failed)
11
12
                      ProcessToken
                   end
13
                else /* token not in TokenPool */
14
                   if (received for the first time)
15
16
                      ProcessToken
17
                   end
18
                end
19
             end
         else /* a token was received */
20
            if (received for the first time)
21
22
                ProcessToken
23
           end
24
         end
25
      end
26 end
```

Figure A7 Agreement Processor

```
LostAgreeToken
   if (joinagree)
2
       if (rank(p_i) > rank(p_i))
3
          return true
4
       else
5
          return false
       end
7 end
   if (failagree)
        \textbf{if } (\textit{RelativeRank}(p_{k} \ , \ p_{i}) > \textit{RelativeRank}(p_{j} \ , \ p_{i}))
9
          return true
10
11
        else
12
           return false
13
       end
14 end
```

Figure A8 Determination of Token Originator's Failure

```
ProcessToken
 1 if (joinregst)
2
           send token to JoinProcessor
3
    elseif (commit)
4
        send token to ComitProcessor
 5
    elseif (agree)
         if ((p_i \neq p_i) &\& (agree \text{ token } \notin TokenPool(p_i))
 6
7
             add agree_{p_i}(p_k) to TokenPool(p_i)
             ST_{P_i}(p_i) \leftarrow FailAgreed or JoinAgreed
             send agree_{p_i}(p_k) to cwnbr(p_i)
9
10
          else
11
             if ((p_i = p_i) \parallel (\forall p_l \mid p_l \rightarrow p_i, p_l \in ST_{p_i}))
                compute rank \forall p_i \in ST_{p_i} with Agreed status
12
                if rank(p_k) = smallest
13
                   send initiate_comit to ComitProcessor
14
15
                 else
16
                     ST_{Pi}(p_k) \leftarrow joinpendg or failpendg
17
                end
18
            end
19
         end
20 end
```

Figure A9 Processing Agree Tokens

```
printf("VUsage: Agreement soc myaddr stmsoc gymsoc tymsoc jpsoc comsoc frontsoc \n");
                               * Get socket descriptors from command line argument. myaddr is (ipaddr,front;back)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if ( (newsoc = accept(soc, (struct sockaddr*) & caller_addr, & clen)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("\Agreement: unix accept error for incoming msg.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("\Agreement: unix read error for incoming msg.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if ( (msglen=readmsg(newsoc, \&buf,"#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* read msg on local socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                               = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                         myaddr = argv[2];
                                                                                                                                                                                                                                                                                                                                                              gvmsoc = argv[4];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           frontsoc = argv[8];
                                                                                                                                                                                                                                                                                                                                                                                        tpmsoc = argv[5];
                                                                                                                                                                                                                                                                                                                                    stmsoc = argv[3];
                                                                                                                                                                                                                                                                                                                                                                                                                                               comsoc = argv[7];
                                                                                                                                                                                                                                                                                                                                                                                                                      ipsoc = argv[6];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            while (TRUE) (
                                                                                                               f(argc!=9)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  exit(-1); }
                                                                                                                                                                                             exit(-1); }
                                                                                                                                                                                                                                                                                  SS
                                                                                                                                                                                              'myaddr, *smsoc, *gvmsoc, *tpmsoc, *jpsoc, *comsoc,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *frontsoc, *buf, token[TOKENMSGLEN+1], *tdn,

    Description: Refer to Fernando's thesis, Chapter 3

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              printf("\Agreement Process: start execution.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              soc, newsoc, clen, msglen, msgtype,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               struct sockaddr_un caller_addr;
                                                                                  * Written by: Shridhar Shukla
                                                                                                               David Pezdirtz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      c(1), *inittlanmsg;
                                                                                                                                                                                                                                                                                                                                                                                        void Execute Agreement();
                                                                                                                                                                                                                                                                                                                                    void Process TokenPool();
                                                                                                                                                                  14 Dec 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *msglist, *tlml;
                                                                                                                                                                                                                                                                                                                                                                                                                    int OriginatorFailed();
                                                                                                                                                                                                                                                                                                         void Integrate Token();
                                                                                                                                                                                                                                                                                                                                                            void Process Token();
                                                                                                                                                                                                                                                   Hinclude "gmputil.c."
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            *argv];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         rondd:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           main(argc,argv)
                                  * Agreement:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            char *gv, *st;
                                                                                                                                                                  * Date:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           ink
Fink
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     Char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                . 5
```

msgtype = un_msg_type(bul);

buf[msglen] = NULL;

```
Process TokenPool(buf, myaddr, tymsoc, strnsoc, gymsoc, jpsoc, comsoc, frontsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ProcessToken(tkn, myaddr, tpmsoc, stmsoc, gvmsoc, jpsoc, comsoc, frontsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("\Agreement: parsing failed for a token msg.\n");
                                                                                                                                                                                                                                                                                                               thal = str2list(buf, "\n#"); /* remove the msg header */
                                                                                                                                                                                                                                                                                                                                                                                      if (getfrom list (tknl, & tkn, 2) = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              gv = GetGroupView(gvmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    st = GetStatusTable(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* get local group view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (first_time(tkn, gv, st))
                                   else ( /* a token is received */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } /* end while (infinite loop) */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* get status table */
                                                                                                                                                                                                                                                                              case TOKENTOKN:
                                                                                                     Case EXTKNPOOL:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              removelist(tknl);
                                                                    switch (msgtype) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 } /* end switch */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         free(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            free(st);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } /* end else */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ) /* end main */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         free(but);
                                                                                                                                                                                                                                                                            Integrate Token (token, tymsoc, stmsoc); /* update local state */
                                                                                                                                                                                                                                             printf("VAgreement: parsing failed for initiate token msg.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* send NULL ack to process requesting initiate token msg */
* create agree token if initiate token: type not checked yet. */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("VAgreement: ack send to token initiator failed.\n"):
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      print("VAgreement: token send to front failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (writemsg(frontfd, token, msglen) < msglen) {
                                                                                                                                                                                                           if (geofromlist(msglist, &inittkrumsg, 2) == 0 ) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (writemsg(newsoc, c, msglen) < msglen) {
                               if (magaype == INITTOKEN) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    frontid = connectUN(frontsoc);
                                                                                                                                                                                                                                                                                                                                                                                    strcpy(token, "tokentokn\n");
                                                                                                                                       maglist = str2list(buf, "vn#");
                                                                                                                                                                                                                                                                                                                                                                                                                       streat(token, inittlenmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     msglen = strien(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* send token to front */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        strcat(token, myaddr);
                                                                                                     /* assemble token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             removelist(msglist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         msglen = strlen(c)
                                                                                                                                                                                                                                                                                                                                                                                                                                                       streat(token, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         streat(token, "#");
```

close(frontfd);

exit(-1); }

c(0) = NULL

exit(-1);)

✓ end if INITIOKEN */

cxit(-1);)

```
printf("\ProcessTokenPool: token pool msg parsing for token %d failed.\n", (i - 3));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Process Token (nextikn, myaddr, tpmsoc, stmsoc, gymsoc, jpsoc, comsoc, frontsxc);
                                                                                                                                                                                                                                                                                                                                                                                                                                       * process the token from the token pool on the following conditions:
                                                                                                                                                                                              b) not in local token pool & i haven't seen the token before
for (i = 4; i \leftarrow \text{to size} + 3; i++) { /* for all tokens in ext tplist */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (OriginatorFailed(nexttkn, gv, myaddr, tp_origin))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              a) in local token pool & the originator has failed
                                                                                                                                                      printf("VExTknPool = 11%slVn", tpmsg);
                                                                         if (getfromlist(tplist, &nexttkn, i) == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (InTokenPool(ltpmsg, nexttkn)){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (first_time(nexttkn, gv, st))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 else { /* token !InTokenPool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | /* end ProcessTokenPool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 process = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                process = TRUE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* end if process */
                                                                                                                                                                                                                                                                                                                   process = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               removelist(tplist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | /* end for i */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (process){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         free(ltpmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  free(umptp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               free(gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       free(st);
*******************
                                                                                                                    void Process TokenPool(tymsg.myaddr.tymsoc.stmsoc.gvmsoc.jpsoc.comsoc.frontsoc)
                                                                                                                                                                                                char *tomsg, *myaddr, *tomsoc, *smsoc, *gvmsoc, *jpsoc, *comsoc, *frontsoc;
                                                                                                                                                                                                                                                                                                                                                         tpsizesting, threq[NODATAMSG+1], *lipmsg, *nextikn, *tmptp,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("vProcessTokenPool: token pool msg parsing for size failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           print("VProcess TokenPool: token pool msg parsing for size failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                               tp_onigin, *t_onigin, *gvreq[NODATAMSG+1], *gv, *st;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msglen, tymfd, tysize, i, gymfd, process;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (getfromlist(plist, &tpsizestmg, 3) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            umptp = CALLOC(strlen(tpmsg) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (geofromliss(tpliss, &tp_origin, 2) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* break out the individual tokens */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      tpmsg = GeTokenPool(tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           gv = GetGroupView(gvmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      plist = str2list(tmptp, "\n=#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           st = GetStatusTable(strnsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* get local group view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      psize = atoi(tpsizestmg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* get local token pool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       strcpy(imptp, tpmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* get status table */
                                          Process Token Pool:
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/* don't check message as only possible is completion flag from commit */
                                                                   printf("\ExecuteAgreement: fail on response from commitn");
                                 printf("vProcessToken: tkn send to commit process failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (InGroup/gymsoc, subject) == -1) { /* subject is NOT in gy */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (InStatus Table(stbuf, subject, (char *) NULL) = FALSE) {
                                                                                                                                                                            /* wait for response back from commit processor */
if (writemsg(comfd, tkmmsg, msglen) < msglen) {
                                                                                                                                                                                                                                              if ((msgkn=readmsg(comfd,&msg,"#")) < 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               stbuf = GetStatusTable(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcpy(tknmsg, "tokentokn'n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /*send token to join process*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* and subject is NOT in st */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ipfd = connectUN(jpsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       msglen = strlen(tknmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* get the status table */
                                                                                                                                                                                                                                                                                                                                                                                                                          msg[msglcn] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               streat(tkmmsg, tkm);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 streat(tknmsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          case JOINRQSTT:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     close(comfd);
                                                                                                       exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  free(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       break:
                                                                                                       void Process Tolean (thm, myaddir, tipmsoc, strnsoc, gvimsoc, jjssoc, comsoc, frontsoc)
                                                                                                                                                                            cher *idn, *myaddr, *tomsoc, *stmsoc, *gymsoc, *ipsoc, *comsoc, *frontsoc;
                                                                                                                                                                                                                                                                                                                   *subject, *stbuf, *cnigin, *gv, *st, ltkn[TOKENMSGLEN+1],
                                                                                                                                                                                                                                                                                                                                               Annag TOKENMS GLEN + 1], request [NODATAMSG + 1],
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 strepy(tlenmsg, "tokentolen\n"); /* send token to commit process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("vProcessToken: parsing failed for token orignator.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("vProcessToken: parsing failed for token subject.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            case FAILCOMIT:; /* processing same for comit tokens */
                                                                                                                                                                                                                                                                                                                                                                                                                          tratype, msglen, comfd, stmsglen, stmfd, jpfd, flag;
                                                                                                                                                                                                                                                                                                                                                                                         status(STSTYPELEN + 1], *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (getfromlist(tknl, &subject, 2) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (getfromfist(that, &origin, 3) = 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     comfd = connectUN(comsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         thanype = GetTokenType(tkn);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          msglen = strlen(tkmmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    streat(tkmmsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              tkn1 = str2list(Itlon, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       streat(thormsg, tho);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           case JOINCOMIT:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcpy(litim, tikn);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            switch(tlantype) {
                                        Process Token:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       cxit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exis(-1);
                                                                                                                                                                                                                                                                                      蒀
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Execute Agreement (tkn, myaddr, tpmsoc, stmsoc, gymsoc, comsoc, frontsoc);
                                                  printf("vProcessToken: tkn send to join process failed.\n");
if (writemsg(jpfd, tknmsg, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             printf("ProcessToken: invalid tokentype\n");
                                                                                                                                                                                                                                                                                              } /* end if subject is NOT in gv */
                                                                                                                                                                                   } /* end if InStatus Table */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   default: /* error condition */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* end ProcessToken */
                                                                                                                                                                                                                                                                                                                                                                                                      CASE FAIL AGREE:
                                                                                                                                                                                                                                                                                                                                                                                                                                CASE JOINAGREE:
                                                                             exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* end switch */
                                                                                                                                 close(ipfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           removelist(tknl);
                                                                                                                                                                                                                                          free(stbuf);
                                                                                                                                                                                                                                                                                                                                                     break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  break:
```

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/ 幸福教授的特殊的政治的特殊的特殊的特殊的 "我们的,我们们们的,我们们的,我们们的,我们的的,我们的的特殊的,我们们的,我们们的,我们们的,我们们的,我们们的,我们
                                                                                                                                                                                                                                                                                                                                                                                        *subj, *orig, likn[TOKENMSGLEN+1], iknmsg[TOKENMSGLEN+1], *msg,
                                                                                                                                                                                                                                                                                                                                            kpreq[NODATAMSG+1], smreq[NODATAMSG+1], *tpbuf, *stbuf, *gvbuf,
                                           void Execute Agreement (token, myaddr, tpmsoc, stmsoc, gymsoc, comsoc, frontsoc)
                                                                                                                                                                                                                                                                                                                                                                                                                                 request[NODATAMSG+1], *member, *tpsizestmg, *tptkn, *tptknsubj,
                                                                                                                                                                                                                      msglen, tpmfd, stmfd, tkntype, duplicate, initcommitphase, maxrank,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          status(STSTYPELEN+1), initcommsg[INITTOKENMSGLEN+1],
                                                                                       char *token, *myaddr, *tpmsoc, *stmsoc, *gvmsoc, *comsoc, *frontsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("\ExecuteAgreement: parsing failed for token subject.\n");
                                                                                                                                                                                                                                                               myrank, subjrank, nextrank, i, tpsize, comfd, gvmfd, frontfd,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* get the subject originator, subject and tokentype */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    updistsmsg[UPDTSTSMSGLEN+1];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (getfromlist(tknl, &subj, 2) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     gvbuf = GetGroupView(gvmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          stbuf = GetStatusTable(strnsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              upbuf = GetTokenPool(tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 tkntype = GefTokenType(ltkn);
                                                                                                                                                                                                                                                                                                           smallest entryrank:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                *tknl, *tpl, *tptknl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          tknl = str2list(ltkn, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* get the group view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* get the status table */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* get the token pool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        strcpy(ltdn, token):
                                                                                                                                                                                                                                                                                                                                                      char
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Ę
                                                                                                                                                                                                                      Z.
```

Execute Agreement:

```
* member between the token subject and myself along the direction
                                                                                                                                                                                                                            * decide not to initiate commit if there is at least one operational
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        subjrank = GetRank(gvbuf, subj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                initcommitphase = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      while ( nextrank != myrank ) {
                                 if (stremp(orig, myaddr) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (nextrank == maxrank)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          nextrank = subjrank + 1;
                                                                initcommitphase = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                            initcommitphase = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (subjrank == maxrank)
                                                                                                                                                                                                                                                                                             * of token circulation.
                                                                                                                             else { /* !originator */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  free(member);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               nextrank = 0;
 /* I'm originator */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         nextrank = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 break;
                               printf("\ExecuteAgreement: parsing failed for token originator.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("\ExecuteAgreement: token send to front failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                      if ( (stremp(orig, myaddt) != 0) && (duplicate == FALSE) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if ( writemsg(frontid, tknmsg, msglen) < msglen) {</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Integrate Token (tkmmsg, tpmsoc, stmsoc);
                                                                                                                                                              if (InTokenPool(upbuf, token) = TRUE) {
if (getfromlist(tknl, &orig, 3) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                           /* if I'm not originator & !duplicate */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end !originator & !duplicate */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        stro; y(thanmag, "tokentolaryn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    frontid = connectUN(frontsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             else { /* originator || duplicate */
                                                                                                                                                                                                                                                                                                                          initcommitphase = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      msglen = strlen(tknmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      * a semble token msg */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* send token to front */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         streat(tknmsg, token);
                                                                                                                                                                                                                                                          duplicate = FALSE; }
                                                                                                                                                                                             duplicate = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          streat(thramsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                close(frontid);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); ]
                                                                                               cxii(-1); }
```

```
printf("\ExecuteAgreement: member with rank %d not there.\n", nextrank);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (InStatusTable(stbuf, member, (char *) NULL) == FALSE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (GetMembWithRank(gvbuf, &member, nextrank) == -1) {
                                                                                      maxrank = GetGroupSize(gvbuf) - 1;
myrank = GetRank(gvbuf, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   nextrank++;
```

```
print("\ExecuteAgreement: token pool parsing for subj of token %d failed.\n", i);
                                                                                                                                                                                                                                                                          if ((strcmp(status, "failagree") = 0) II (strcmp(status, "joinagree") = 0)) {
                                                                if (smallest == TRUE) { /* send initiate token to commit processor */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* type */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* header */
                                                                                                                                                                                                        if (InStatus Table(stbuf, tptknsubj, status) == TRUE) {
if (getfromlist(tptknl, &tptknsubj, 2) == 0) {
                                                                                                                                                                                                                                                                                                                                                entryrank = GetRank(gybuf, tptknsubj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* end if subjrank > entryrank */
                                                                                                                                                                                                                                                                                                             subjrank = GetRank(gybuf, subj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (strcmp(status, "failagree") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(initcommsg, "inittoken\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* get the smallest token's status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            InStatusTable(stbuf, subj. status);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* end if(InstatusTable ...) */
                                                                                                                                                                                                                                                                                                                                                                                                                  if (subjrank > entryrank)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    smallest = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } /* end if( "agree" ) */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       removelist(tptknl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 removelist(tptknl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } /* end for i */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       removelist(tpl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         break:
                                                                                                       exit(-1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("\ExecuteAgreement token pool parsing for token %d failed.\n", (i-2));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* the for loop below for all entries in the token pool with
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      : token pool size = 1%dlvn", tpsize);
```

if (geofnormlist(tpl, & tpsizestrng, 2) = 0)

tpl = str2liss(tpbuf, "\n=#");

if (initcommitphase = TRUE) {

smallest = TRUE;

* agree status

} /* end orginator II chaplicate */

} /* end else !originator */

} /* end while nextrank */

free(member);

if (getfromlist(tpl, &aptkn, i) == 0) {

printdatabase(tpl, 4);

print("\

tpdknl = str2list(tpdkn, " ");

exit(-1);)

for (i = 3; i < tpsize + 3; i + +) {

tpsize = atoi(tpsizestrng);

exit(-1); }

```
# don't check message as only possible is completion flag from commit */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("VExecuteAgreement: init comit send failed for %s\n", subj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* subject for token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           print("VOTALLIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICALIMICA
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    else { /* ismallest -> update status with appropriate pending status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                print("\ExecuteAgreement: fail on response from commit\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* end of msg */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* separator */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* ### wait for response back from commit processor */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (writemsg(comfd, initcommsg, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if ((msglen=readmsg(comfd,&msg,"#")) < 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   \ /* end then (smallest == TRUE) */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    strepy(updastsmsg, "updstatus'n");
                                                                                                                                                                                                                                     streat(initcommsg, "joincomit");
streat(initcommsg, "failcomit");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         comfd = connectUN(comsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msglen = strlen(initcommsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* send initiate comit msg */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            streat(initcommsg, subj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       streat(updtstsmsg, subj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      streat(initcommsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 streat(initcommsg, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           streat(updtstsmsg, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   msg[msglen] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     close(comfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
```

```
printf("\Execute Agreement: incorrect status |%s/n", status);
                                                                                                                                                                                                                                                                                                                      printf("\ExecuteAgreement: status update to stm failed\n");
                                                                                                                                                                          /* send update status message to status table manager */
                                                                                                                                                                                                                                                                                            if ( writemsg(stmfd, updtstsmsg, msglen) < msglen) {</pre>
                                                                                                                                                                                                                                    strnfd = connectUN(strnsoc);
                                                                                                                                                                                                      msglen = strlen(updtstsmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* end if inicommitphase */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } /* end ExecuteAgreement */
                                                                                                                   streat(updtstsmsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } /* end else !smallest */
                                                                                                                                                                                                                                                                                                                                                                                                                                           close(stmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  removelist(tknl);
                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(tpbul);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ree(gybuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          free(stbuf);
```

else if (strcat(updtstsmsg, "failpendg");

If (strcmp(status, "joinagree") == 0) strcat(updtstsmsg, "joinpendg");

```
printf("VintegrateToken: local token copy parsing for tokentype failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      printf("VintegrateToken: status update to status table manager failed.\n");
                                                                  /* send update status message to status table manager */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (writemsg(fd, updistsmsg, msglen) < msglen) {
if (getfromlist(tokenlist, &tokentype, 2) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                         if (stremp(tokentype, "joinagree") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (stremp(tokentype, "joincomit") = 0)
                                                                                                                                                                                                                                                                                   if (stremp(tokentype, "failcomit") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (stremp(tokentype, "jointeqst") = 0)
                                                                                                                                                                            if (stremp(tokentype, "failagree") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                             strcpy(statustype, "joinagree");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    strepy(statustype, "delstatus");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(statustype, "joinrqstd");
                                                                                                                                                                                                              strcpy(statustype, "failagree");
                                                                                                                                                                                                                                                                                                                       strcpy(statustype, "delstatus");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  streat(updtstsmsg, statustype);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             msglen = strlen(updtstsmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 fd = connectUN(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* end IntegrateToken */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  streat(updastsmsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         removelist(tokenlist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                        exit(-1): }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                close(fd);
indexismsg[UPDTSTSMSGLEN+1], localtoken[TOKENMSGLEN+1],
                                    integrate Token: updates the token pool and the status table for token after adding
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      print("VinegrateToken: local token copy parsing for subject failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                print("Vintegrate Token: token send to token pool manager failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *subject, *nokentype, statustype(STSTYPELEN + 1];
                                                                                                          ***************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (writemsg(fd, tlarmsg, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* send a token msg to token pool manager */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (getfromlist(tokenlist, & subject, 3 = 0) {
                                                                                                                                        void Integrate Token (tlanneg, tpmsoc, stmsoc)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               iokenlist = str2list(Incaltoken, "\n #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* assemble update status message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                strcpy(updistsmsg, "updstatus\n");
                                                                        appropriate message types
                                                                                                                                                                              ther "tionneg, "tumsoc, "stmsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          fd = connectUN(tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 stropy(localtoken, tlannsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                streat(updtstsmsg, subject);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        msglen = strlen(tknmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            streat(updestsmsg, " ");
                                                                                                                                                                                                                                                                                       msglen, fd;
                                                                                                                                                                                                                                                                                                                                                                                               tokenlist.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            cxii(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         cxis(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           close(fd);
                                                                                                                                                                                                                                                                                                                           퉝
                                                                                                                                                                                                                                                                                                                                                                                             İ
```

```
printf("NOnginatorFailed: tp originator not in gv.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("AOriginatorFailed: tp originator not in gv.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if ((\pi_0 = \text{RelativeRank}(gv, \text{crigin}, \text{myaddr})) < 0)
                                                                                                                                                                                          printf("VOriginatorFailed: i'm not in gv.\n");
                                                                                                                                                             if ((myrank = GetRank(gv, myaddr)) < 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 rr_s = RelativeRank(gv, subject, myaddr);
if ((rank_0 = GetRank(gv, origin)) < 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (tokentype == FAILAGREE){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* end OriginatorFailed */
                                                                                                                                                                                                                                                                                                                           if (rank_o > myrank){
                                                                                                                                                                                                                                                                                                                                                                                                                                                       } /* end if joinagree */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* end Failagree */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               failed = TRUE;
                                                                                                                                                                                                                                                                                                                                                        failed = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (n_0< n_s)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             removelist(list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(tmp_tkn);
                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         return(failed);
                                                                                               exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                         *********************************
                                                                                                                                                             RelativeRank(p_cnigin, myaddr) < RelativeRank(subject(token), myaddr)
                                                                                                                                                                                                                                                                                                                           rank(tp_origin) > rank(myaddr) and token is a "joiragree" token
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             printf("NOnginatorPailed: token parsing for subject failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        failed, n_o, n_s, rank_o, myrank, tokentype;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    tmp_tkn = CALLOC(stricn(token) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        int OriginatorFailed(token, gv, myaddr, origin)
                                                                                                                                                                                              and token is a failagree' token
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (getfromlist(list, & subject, 2) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             iokentype = GefTokenType(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         char *token, *gv, *myaddr, *origin;
                                                                                                                                                                                                                                                                                                                                                                                         otherwise return FALSE
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (tokentype == JOINAGREE){
                                                                                                                                                                                                                                                            ಕ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   list = str2list(tmp_tlon, "\n #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      cher *subject, *tmp_tkn;
                                                                                               return TRUE if:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       stropy(tmp_tlm, tolken);
```

Originator Failed:

failed = FALSE;

COMMIT PROCESSOR

Commit Processor - Process Dependencies	132
Actions for Committing a Change	133
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CommitProcessor	134

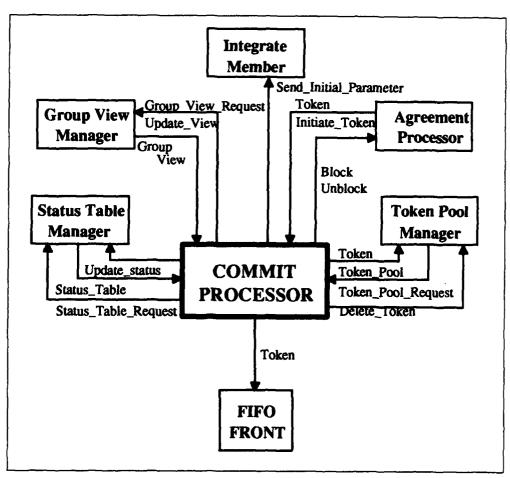


Figure A10 Commit Processor - Process Dependencies

```
CommitChange for commit<sub>pi</sub>(p_k) at p_i
    /* Depending on whether a join or departure */
1 add or delete p, from GV(p_i)
2 delete p, entry from ST_{Pi}
3 \quad vn(p_i) \leftarrow vn(p_i) + 1
4 delete all commit tokens received before agree_{p_i}(p_k) from TokenPool(p_i)
    if (join committed && joinreq<sub>Pi</sub>(p_k) \in TokenPool(p_i))
6
       delete joinreq_{p_i}(p_k)
7
    end
8 add commit_{p_i}(p_k) to TokenPool(p_i)
9 delete agree<sub>p</sub>(p<sub>k</sub>)
10 if (current host = p_{\mu})
11
       determine new phost
12 end
13 if ((join committed) && (p_{host} = p_i))
       send ST_{p_i}, TokenPool(p_i), and GV(p_i) to acwnbr(p_i)
16 send commit_{p_i}(p_k) token to cwnbr(p_i)
   end CommitChange
```

Figure A11 Actions for Committing a Change

```
ProcessCommitTkn for commit<sub>pi</sub>(p_k) at p_i
   if (initiate commit message received)
2
      generate commit token
3
      token to be processed ← generated token
   else if ((p_i \neq p_i) \&\& (not duplicate))
      token to be processed ← received token
6
    else
7
      exit
   end
9 CommitChange
10 while (p_i \in ST_{p_i}) with pending status & Rank(p_i) < Rank(p_m), p_m \in ST_{p_i}
11
      generate commit token
      token to be processed ← generated token
12
13
      CommitChange in rank order
14 end
```

Figure A12 Generate / Receive and Process a Commit Token

```
printf("VUsage: Commit soc myaddr strnsoc gymsoc tymsoc intribrisoc frontsoc\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ( (newsoc = accept(soc, (struct sockaddr*) & caller_addr, & clen)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("vCOMMIT: accept error error %dvi", erro).
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if ( (msglen = readmsg(newsoc, \&but, "#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("\COMMIT: read error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* read message on local socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             msgtype = in_msg_type(bul);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            clen = sizeof(caller_addr);
                                                                                                                                                                                                    = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            buf[msglen]=NULL;
                                                                                                                                                                                                                           myaddr = argv[2];
                                                                                                                                                                                                                                                                           gvmsoc = argv[4];
                                                                                                                                                                                                                                                                                                                             introprsoc = argv[6];
                                                                                                                                                                                                                                                                                                                                                     frontsoc = argv[7];
                                                                                                                                                                                                                                                                                                     tpmsoc = argv[5];
                                                                                                                                                                                                                                                     = \operatorname{argv}[3];
                                                                                                                                                                                                                                                                                                                                                                                                     while (TRUE) (
                                                 if (argc!=8) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); }
                                                                                                                          exit(-1); }
                                                                                                                                                                                                                                                        Stmsoc
                                                                                                                                                                                                       8
                                                                                            streq[NODATAMSG+1], *myaddr, *buf, *gv, *tpool, *sttable, *tkndata,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  *originator, *smsoc, *gymsoc, *tpmsoc, *intmbrsoc, *frontsoc
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         depreqNODATAMSG+1+1], token[TOKENMSGLEN+1],
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            soc, newsoc, gvmfd, tpmfd, stmfd, clen, msglen, msgtype,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   *ump_token, *ump, msg[10];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 gyreq[NODATAMSG+1],
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  struct sockaddr_un_caller_addr;
* Written by: Fernando Pires
                      David Pezdirtz
                                                                                                                                                                                                                                                                                                     typedef struct node node;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Process_token;
                                                                       9 Dec 1993
                                                                                                                                                                                                                                                                                                                                                void Commit_Change();
                                                                                                                                                                                                                                                                                                                                                                                                                             node *order_pending();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         *head, *ptr;
                                                                                                                                                                                                                                                   struct node*next; );
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    *msglist;
                                                                                                                                                                                                                                                                                                                                                                          void DeleteTakens();
                                                                                                                         Finchole "gmputile"
                                                                                                                                                                                                                                                                                                                                                                                                                                                   node *make_node();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   main(argc,argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    char *argv[];
                                                                                                                                                                                                                           char*data;
                                                                                                                                                                          struct node
                                                                                                                                                                                                    int rank;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            int argc;
                                                                      * Date:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         node
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               S
S
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           Ĭ.
```

*Get socket file descriptors from the command line. myaddr is (ipaddr;fromt;back)

printf("wCOMMIT: start execution.\n");

* Algorithm: Fig. 6-7 of the grap paper

* Commit Processor.

```
/* get local token pool */
tpool = GeffokenPook(tpmsoc);
```

/* get group view */ gv = GetGroupView(gvmsoc); /* get status table */ strable = GetStatus Table(strusoc);

Process_token=FALSE;

if (msgtype == INTTOKEN){ /* create commit token */ /* assemble token */ msglist = sr2list(buf, "v#"); if (getfromlist(msglist, &dandata, 2)!=2) {
 print("vCOMMIT: initioken msg parsing failed\n");
 print("vO75\$
 exit(-1); }
exit(-1); }

stropy(token, thodata); stroat(token, "); stroat(token, myaddr); stroat(token, "#"); removelist(msglist); Process_token = TRUE; /* and then msgtype = INITTOKEN */

<u>왕</u>

/* process incoming token */

free(buf);

```
if ((stremp(originator,myaddr) != 0) && (first_time(token, gv, stable)))
                                                                                                                                                                                                                     printf("vCOMMIT: token msg parsing failedn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("vCOMIMIT: token msg parsing failed'n");
                            imp_token = CALLOC( strken(bul) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (getfromlist(msglist, &originator, 4)!=4) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } /* end else msgrype != INITTOKEN */
                                                                                                                                                        if (getfromlist(msglist, &tmp, 2) != 2) {
/* strip off the "tokentokn" field */
                                                                                          msglist = str2list(mp_token,"\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* change already committed */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        msglist = str2list(buf, "\n #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Process_token = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* commit the change */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          Process_token = TRUE;
                                                            strcpy(tmp_token, buf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /* get the originator */
                                                                                                                                                                                                                                                                                                                                                                               removelist(msglist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  removelist(msglist);
                                                                                                                                                                                                                                                                                                                   strcpy(token,tmp);
                                                                                                                                                                                                                                                                                                                                                                                                             free(tmp_token);
                                                                                                                                                                                                                                                   exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
```

```
to ptr, agree, pending, rank, st_ptr, done, finish, found, tpsize,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                *nxt_token, *tp_subj, *tk_type, tpsizestr, *temp_tp, *temp_st,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          stlist = str2list(temp_st, "vr=#"); /* break out elements and status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("\ProcCommitPending: token subject parsing failed\n");
                                            order_pending: creates a linked list of the commit processes.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        "tktemp, "subject, "st_subj, "status, "temp_tk,
                                                                                                                                                              node *order_pending(tpool, gv, stable, token, myaddr)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   lemp_s x = CALLOC(strlen(strable) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            temp_tk = CALLOC(strlen(token) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   temp_p = CALLOC(strlen(tpool) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (getfromlist(tkn_list, & subject, 2)!=2){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* insert commit token at begining of list */
                                                                                                                                                                                                      char *tpool, *gv, *stable, *token, *myaddr;
                                                                                                                                                                                                                                                                                                                                                              "head, "point, "last, "temp, "ptr;
                                                                                                                                                                                                                                                                                                                        *tplist, *tklist, *stlist, *tkn_list;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          t_{rad} = str2list(temp_tk, "vn #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               plist = str2list(temp_p, "vn=#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  head = make_node((-1), token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* get current token subject */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* disassemble status table */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* disassemble token pool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* get commit token subj */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    stropy(temp_tk, token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(temp_st,sttable);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(temp_tp,tpool);
                                                                                                                                                                                                                                                                                                                                                                                                                                            lowest rank;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              'new_token;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    S
Par
                                                                                                                                                                                                                                                                                                                          喜
                                                                                                                                                                                                                                                                                                                                                              Commit_Change(tpool, tmp_token, myaddr, gvmsoc, tpmsoc, stmsoc, intrubrsoc,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  tmp_token = CALLOC(strien(head->data) + 1, char);
                                                                                     head = order_pending(tpool, gv, stable, token, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (writemsg(newsoc, msg, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("vCommit unblock agree failed/n");
                                                                                                                                                                                                                                                                             strcpy(tmp_token, head->data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* end if (Process_token) */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     strcpy(msg, "unblock#");
                                                                                                                                                              while (head != NULL)
```

head = pt->next;

ptr = head;

if (Process_token) (

free(ptr->data);

free(ptr.);

msglen = strlen(msg);

} /* while (TRUE) */

free(sttable);

} /* end main */

close(newsoc);

free(thool); free(gv);

xii(-1); }

} /* end while ptr */

free(tmp_token);

```
printf("Vorder pending: token type parsing failedvn");
                             if (getfromlist(tklist, &tk_type, 1)!=1) {
 /* get next token type */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | /* endelse */
                                                                                                                       exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     free(tktemp);
                                                                                                                                                                                                                                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* get rank */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    to purty;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* parse status table - add all members to list in rank order */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (getfromlist(tplist, &nxt_token, tp_ptr)!= tp_ptr){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  tkacemp = CALLOC(strken(nxt_token) + 1, char);
                                                                                                                                                                                                                                                                                                       if (getfromlist(stlist, & status, st_ptr+1) !=(st_ptr+1)){
                                                                                                                                                                                                                                                                                                                                       print("Norder pending: status parsing failed/n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("Norder pending: token not found\n");
                                                                                                                                                                                  if (getfromlist(stlist, &s. subj, s. ptr) != s. ptr)
                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* check for joinreqst status ... ignore it */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* get the corresponding agree token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             tklist = st2list(tktemp, "\n #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* check for end of token pool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (stremp(status, "joirnqstd") !=0){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* check for proper token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 strcpy(tktemp, nxt_token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          while (done != TRUE){
                                                                                                                     while (finish != TRUE) {
                                                                                                                                                                                                                                                                          /* get the status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  done = FALSE;
                                                                                                                                                                                                               finish = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                        finish = FALSE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   tp_ptr=3;
                             st_ptr=3:
                                                                                                                                                                                                                                                - Se
```

```
printf("Vorder pending: token subject parsing failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* go back and look for next token in token pool */
                                                                                                                                                                                                                                                                                                          if ((agree) && (strcmp(\mathfrak{p}_subj, st_subj) == 0))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* member not in GV ---> MUST be a join */
                                   if (getfromlist(tklist, &tp_subj, 2) !=2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* free storage ONLY if token not found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if ( (rank = GetRank(gv, tp_subj)) < 0) {
                                                                                                                                                                                                                                             agree = agreetoken(nxt_token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  rank = HIGHRANK VALUE;
/* get next token subj */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (done = FALSE)
                                                                                                                                                                                                         /* if agree token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          } /* end while !done */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          removelist(tklist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    } /* end if rank < 0 */
                                                                                                                                                                                                                                                                                                                                               done = TRUE;
```

```
if ((stromp(status, "joinpendg") = 0) I (stromp(status, "faitpendg") = 0)) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* don't insert a token for the corresponding commit token */
                                                                                                                                                                                                                                                                                                   new_token = CALLOC(TOKENMSGLEN+1, char);
                                                                                                                                  while ( (point != NULL) && (rank > point->rank) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             temp = make_node(rank, new_token);
                                                                                                                                                                                                                                                                                                                                                                                                      if (stremp(status, "joinpendg") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (stremp(status, "failpendg") == ()
                                                                                                                                                                                                                                                                                                                                                                                                                                        strcpy(new_token, "joincomit");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       strepy(new_token, "failcomit");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (stremp(tp_subj, subject) != 0){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strcpy(new_token, "agree");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           streat(new_token, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end if status != joinnqstd */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           streat(new_token, tp_subj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              temp-ynext = last-ynext;
                                                                                                                                                                                                                                                                   /* create commit token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         streat(new_token, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          streat(new_token, "#");
/* find insertion point */
                                                                                                                                                                                                     point = point->next; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* insert in order */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                last->next = temp;
                                                                point = last->next;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          removelist(tklist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(new_token);
                                                                                                                                                                    last = point;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(tktcmp);
                                best = head:
```

```
* NOTE: the first "agree is NOT the corresponding agree for this
                                                                                                                                                                                                                                                                                                                                                    /* all tokens w/ subj in status table now ordered
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (strcmp(point->data, "agree") = 0){
/* incriment pointer for next status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* remove the end of the list */
                                                                                                                                                                                                                                                                                                                                                                              * discard all past first "agree"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      while (point != NULL){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             point = ptr->next;
                                                                             /* end if next status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              last->next = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      free(ptr->data);
                                                                                                       /* end while !finish */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        while (finish != TRUE){
                           st_ptr = st_ptr + 2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (point = NULL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ptr = point;
                                                                                                                                                              removelist(tkn list);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     finish = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            point = last->next;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               free(ptr);
                                                                                                                                                                                       removelist(tplist);
                                                                                                                                                                                                                 removelist(stlist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   finish = FALSE;
                                                                                                                                                                                                                                           free(temp_tk);
                                                                                                                                                                                                                                                                     free(temp_tp);
                                                                                                                                                                                                                                                                                                free(temp_st);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                commit
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 last = head;
```

```
delidar[DELTKNLEN+1+2], gvraq[NODATAMSG+1], srdinip(SNDINIPLEN+1],
void Commit_Change(tpool, token, myaddr, gvmsoc, tpmsoc, stmsoc, intmbrsoc, frontsoc)
                                                                                                                                                                                                                                                                                              "Matemp, "uktype, "subject, "originator, updaview[UPDTVIEWLEN+1],
                                                                                                                                                                                                                                                                                                                                                       updis(UPDTSTSMSGLEN+1), *gview, *host, *token, *upool,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               msglen, gymfd, tprnfd, stmfd, intmbrfd, fro. afd, joinc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           printf("Commit_Change: token originator parsing failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              printf("Commit_Change: token subject parsing failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("Commit_Change: token type parsing failed\n");
                                                                                                                                                char *tpool, *token, *myaddr, *gvmsoc, *tpmsoc, *stmsoc,
                                                                                                                                                                                                                                                                                                                                                                                   lkpreq[NODATAMSG+1], *faux_token;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (getfromlist(tklist, &originator, 3)!=3) [
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      iktemp = CALLOC(strlen(token) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (getfromlist(tklist, & subject, 2) !=2) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (getfromlist(tklist, &tktype, 1)!=1) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* set joincommit token flag */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                klist = str2list(tktemp, "An #");
                                                                                                                                                                              *intmbrsoc, *frontsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* get token elements */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  strcpy(tktemp,token);
                                                                                                                                                                                                                                                                                                                                                                                                                                             *tklist;
                                 Commit Change:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 joinc = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          exit(-1); }
                                                                                                                                                                                                                                                                                              char
                                                                                                                                                                                                                                                                                                                                                                                                                                             link
                                                                                                                                                                                                                                                                      Ħ.
                                                                                                                                                                                                                                                                                                                                                                                                                                             imp->data = CALLOC(surlen(data) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         returns the node ptr to the created node.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       node -> rank = rank of current
                                                                                                                                                                                                          } /* end if point != NULL */
                                                                                                                                                                                                                                                                                                                                                                                                                                             ********
                                                             else ( /* continue parse */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  node *make_node(re: !:, 'eata)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   mp = CALLOC(1, node);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              make node: creates a node
                                                                                                                                                                                                                                                                                                                                                                                     /* end order_pending */
                                                                                                                     point = last->next;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              node -> next = NULL
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        strcpy(tmp->data,data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* end make_node */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     node -> data = data
     finish = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  Imp->next = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   tmp->rank = rank;
                                                                                         last = point;
                                                                                                                                                                                                                                                                  /* end!finish */
                                                                                                                                                                                                                                                                                                                              return(head);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              return(tmp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             node *ump;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            char *data;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ini rank;
```

if (writemsg(gvmfd, updtview, msglen) < msglen) { /* assemble update view (delete) message */ if ((stromp(tktype, 'failcomit')=0)) { stropy(updtview, "updatview\ndel"); gwnfd = connectUN(gwnsoc); msglen = strlen(updtview); streat(updrview, subject); streat(updtview, "#");

print("\Commit_Change: update view tx failed\n"); exit(-1); }

close(gvmfd);

/* token is a joincommit */ /* end else failagree' */ joinc =: TRUE; /* assemble update view (add) message */ stropy(updtview, "updatview\radd"); strcat(updrview, subject); streat(updtview, "#");

gvmfd = connectUN(gvmsoc); msglen = strlen(updtview);

print("NCommit_Change: update view tx failed\n"); if (writemsg(gymfd, updtview, msglen) < msglen) {

close(gvmfd);

gview = GetGroupView(gvmsoc); /* get updated group view */

* determination if token in pool */ /* originator field not checked for /* tokentkn field not required */ faux token = CALLOC(TOKENLEN + 1, char); /* assemble the faux joinregst token */ strcpy(faux_token, "joinregst"); streat(faux_token, myaddr); streat(faux_token, subject); strcat(faux_token, " "); strcat(faux_token, "#");

if ((CetRank(gview,myaddr)!=0) && (InTokenPool(tpool, faux_token))) { /* delete joinregst token if I'm not host and token is in pool */

/* assemble delete token (joinregst) message */ strcpy(deltlan, "delttoken\njoinneqst");

streat(deltkn, originator); streat(deltkn, subject); strcat(deltlm, "#"); streat(deltlm, " ");

tormid = connectUN(tormsoc);msglen = strlen(deltkn);

printf("vCommit_Change:delete token tx failer\n"); if (writemsg(tpmfd, deltkn, msglen) < msglen) { exit(-1); }

close(tpmfd);

} /* end if GetRank && InTokenPool */

free(faux_token);

if (GetMembWithRank(gview, &host, 0)!=0), printf("\Commit_Change: get host failed\n"); exit(-1); }

```
/* ensure that the changes have been incorporated in the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           printf("vCommit_Change:delete token tx failedvn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                token pool prior to sending the initial parameters
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (writemsg(tpmfd, deltkn, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if ((joinc) && (stremp(host, myaddr) == 0))
/* assemble delete agree token message */
                                                                                               if (strcmp(tktype, "failcomit") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               introbrfd = connectUN(introbrsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* send SendInitialParameters */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ttpool = GerTokenPool(tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             strcpy(sndinip, "sndinipar\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             NOTE: async consideration
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     tomfd = connectUN(tpmsoc);
                            strepy(deltkn, "delttoken\n");
                                                                                                                                                                                                  streat(deltkn, "joinagree");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 msglen = strlen(sndinip);
                                                                                                                                 streat(deltkn, "failagree");
                                                                                                                                                                                                                                                                                                                                    strcat(deltkn, originator);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                streat(sndinip, subject);
                                                                                                                                                                                                                                                                                                                                                                                                                                         msglen = strlen(deltkn);
                                                                                                                                                                                                                                                                     streat(deltkn, subject);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                streat(sndinip, "#");
                                                                                                                                                                                                                                                                                                                                                                      strcat(deltkn, "#");
                                                                                                                                                                                                                                                                                               strcau(deltlan, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                free(upool);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              close(tpmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("vCommit_Change: update status tx failed'n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ticken = CALLOC(strlen(token) + 9 + 1 + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (writemsg(tpmfd, ttoken, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("vCommit_Change: taken tx failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                       if (writemsg(stmfd, updtst, msglen) < msglen) {
                                                                                                                                 * assemble update status (delete) message */
                                                                /* and else assemble update view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Delete Tokens(tipool, token, tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            tipool = GeTokenPool(tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              tpmfd = connectUN(tpmsoc);
                                                                                                                                                                                                                                                                                                                                      stmfd = connectUN(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strepy(ttoken,"tokentokn\n");
                                                                                                                                                                  stropy(updist, "updstatus\n");
                                                                                                                                                                                                                                streat(updist, "delstatus f");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* get local token pool */
```

close(strnfd);

exu(-1); }

msglen = strlen(updtst);

streat(updtst, subject);

free(gview);

/* send token to TPM */

msglen = strlen(ttoken);

close(tpmfd);

exif(-1); }

strcat(ttoken,token);

```
/如你的你的你的你的话,我们我们我们我们的我们的,我们的我们的,我们的我们的我们的我们的我们的,我们的我们的我们的我们的,我们的我们的我们的,我们的人们的人们的
                                                                                                                                                                                                                                                               'tytemp, *poolsize, *tktemp, *subject, *nxttkn, *nxttktemp,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("vProcCommitPending: token pool size parsing failed\n");
                                                                                                                                                                                                                                                                                       *nxttype, *nxtsubj, *nxtorig, delikn|DELTKNLEN+1];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    lktemp = CALLOC(strten(token) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                          ptemp = CALLOC(strlen(tpool) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (getfromlist(tplist, &poolsize, 2)!=2) {
                                                                                                                          void Delete Tokens(tpool, token, tpmsoc)
                                                                                                                                                                                                                                                                                                                     *tplist, *tklist, *nxttklist;
                                                                                                                                                                                                                                         psize, i, msglen, tpmfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 tplist = str2list(uptemp, "\n=#");
                                                                                                                                                                                                                                                                                                                                                                               /* disassemble token pool */
                                                                                                                                                    char *tpool, *token, *tpmsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   psize = atoi(poolsize);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* get token subject */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                strcpy(tktemp,token);
                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(tptemp,tpool);
                                        DeleteTokens:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                  다
발
                                                                                                                                                                                                                                                                                                                            真
                                                                    printf("vCommit_Change: token tx to front failed\n");
                  if (wniecmsg(inumbrfd, sndinip, msglen) < msglen ) {
                                            print("vCommit_Change: sndinipar tx failedn");
                                                                                                                                                                                                                                                                                                                                                                                                                                              if (writemsg(frontfd, troken, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                 /* send token to FRONT -> cwnbr */
                                                                                                                                                                                                                                                                                                                                                                                           frontfid = connectUN(frontsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | /* end Commit_Change */
                                                                                                                                                                                                                                                                                                                                                              msglen = surlen(noken);
                                                                                                                                                                                                                      /* end if stremp */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  removelist(tklist);
                                                                                                                                                               close(intembrfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           close(frontfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           free(tktemp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        free(troken);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     free(upool);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   exti(-1); }
                                                                                                                                                                                                                                                                            free(host);
```

```
print("VProcCommitPending: token pool parsing failed for token %dvn", i);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("AProcCommitPending: next token originator parsing failed'n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               print("\ProcCommitPending: next token subject parsing failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          print("\ProcCommitPending: next token type parsing failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                if ((agreetoken(nxtikn)) && (strcmp(nxtsubj, subject)==0))
                                                                                                                                                                                                                                               extitizemp = CALLOC(stricn(nxttkn) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (getfromlist(nxttklist, &nxtorig, 3)!=3) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (getfromlist(nxttklist, &nxtsubj, 2) != 2) {
                                                                                                                                                                                                                                                                                                                                                                                             if (getfromlist(nxttklist, &nxttype, 1)!=1)[
if (getfromlist(tplist, &nxttkn, i) != i) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* assemble delete token message */
                                                                  printf("Ntpoolsize = %dn", tpsize);
                                                                                                                                                                                                                                                                                                                      nxtiklist = str2list(nxtiktemp, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strcpy(deltlm, "delttoken\n");
                                                                                                                                                                                                                                                                                      strcpy(nxtiktemp, nxtikn);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* stop at agree(subject) */
                                                                                                                                                                                                            /* get next_token fields */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (comittoken(nxttkn)){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  streat(deltlen, nxtsubj);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             strcat(delitin, nxttype);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                streat(deltkn, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     streat(delitkn, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* delete token */
                                                                                                                                       exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); }
```

```
printf("vCommit_Change:delete token tx failedvn");
                                                                                                                                              if (writemsg(tpmfd, deltkn, msgken) < msgken) {
                                                                                                                                                                                                                                                                                                                         /* end if stremp(nxttype, "failcomit") */
                                                                                                 pmfd = connectUN(tpmsoc);
                                                                         msglen = strlen(deltkn);
streat(deltkn, nxtorig);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* end DeleteTokens */
                                                                                                                                                                                                                                                                                                                                                                           removelist(nxttklist);
                        strcat(deltkn, "#");
                                                                                                                                                                                                                                                                                                                                                                                                   free(nxttktemp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   removelist(tplist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         removelist(tklist);
                                                                                                                                                                                                                                                                         close(tpmfd);
                                                                                                                                                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* end for i */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   free(tptemp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           free(tktemp);
```

INTEGRATE MEMBER PROCESS

Process Dependencies	145
Process Specification	145
Integrate Member Code	146

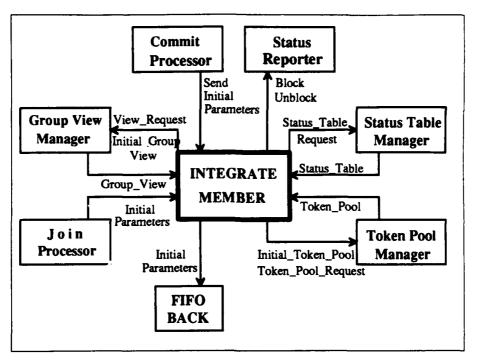


Figure A13 Integrate Member - Process Dependencies

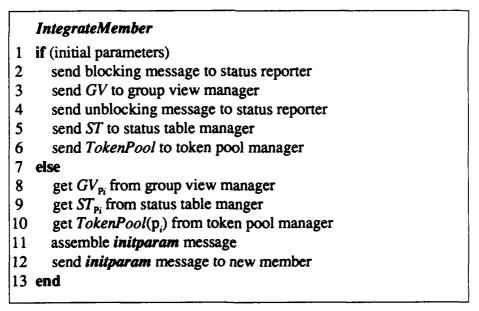


Figure A14 Integrate Member Process Specification

```
printf("INTMBR usage error: intmbr soc my_addr gymsoc strnsoc tymsoc backsoc\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if ( (newsoc = accept(soc, (struct sockaddr*) &caller_addr, &cden)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           print("\07$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if ( (msglen = readmsg(newsoc, &buf, "#")) < 0) {
   *my_addr, *target;
                                                                                                           *msgl1, *msgl2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* Accept connection request from client */
                                                       caller_addr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("VINTMBR: accept errorh");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("VINTMBR: read error\n");
                                  action;
                                                                                 *buf;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          buf[msglen] = NULL;
                                                                                                                                                                                          soc = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                            backsoc = argv[6];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* Read message */
                                                                                                                                                                                                                    my_addr = argv[2];
                                                                                                                                                                                                                                              gvmsoc = argv(3);
                                                                                                                                                                                                                                                                                                  torsoc = argv[5];
                                                                                                                                                                                                                                                                        stmsoc = argv[4];
                                                     struct sockaddr_um
                                                                                                                                                               f(argc=7)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  while (TRUE)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                exit(-1); )
                                                                                 char
                                                                                                         <u>li</u>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          · 一个,我们的人们的,我们们的一个,我们的人们的,我们的人们的,我们们的,我们们的人们的,我们的人们的,我们的人们的人们的,我们们的人们的人们的,我们们们的人
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        Sends the init sub-msg to the 3 data base managers. On initial param
                                                                                                                                                                                                                                              request, compiles the init_params and returns the init_param msg.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             *gvmsoc, *smsoc, *tpmsoc, *backsoc;
                                                                                                                                                                                       Waits for a connection and then reads the initial parameter msg.
                                                                                                                                                                                                                                                                                                 * USACE: intembr soc my_addr gymsoc strnsoc tymsoc backsoc
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    soc, newsoc, clen, msglen;
                         * Integrate Member (INTMBR)
                                                                                                           * Author: David Pezdirtz

    Version: 19 May 1993

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       typedef char *buffer;
                                                                                                                                                             * DESCRIPTION:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            finclude "msgutill."
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Finchude "socutile."
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ****
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      *argv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               #include "gmp.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    main(argc, argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Declarations
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            wid demux();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        void mux();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Main
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Sar
```

```
demux: break apart the initial parameters message and send the sub-msgs
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("INTMBR: getfromlist invalid format (graview)/n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             print("VINTMBR: initgview to gvm failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* convert group view to list as only member */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (writemsg(gvmfd, msg, msglen) < msglen) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (getfromlist(msgl1, &temp_data, 3) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* generate the initial group view message */
                                                                                                                                            w 1 demux (msgl1, gvmsoc, stmsoc, tpmsoc)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* send the initial group view to gvm */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   msg = list2str(msgl2, header, "\n", "#");
                                                                                                                                                                                                                                                                                     gvmfd, stmfd, tpmfd, msglen;
                                                        to the individual database managers.
                                                                                                                                                                                                    char *gvmsoc, *stmsoc, *tpmsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            header = CALLOC(9 + 2, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               msg12 = st2list(temp_data,"#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              gvmfd = connectUN(gvmsoc);
                                                                                                                                                                                                                                                                                                                                           "msg, "temp_data;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strcpy(header,"initgview");
                                                                                                                                                                                                                                                                                                                                                                                                                                 /* get the group view */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msglen = strlen(msg);
                                                                                                                                                                                                                                                                                                                                                                        *header:
                                                                                                                                                                                                                                                                                                                  msgl2;
                                                                                                                                                                         lis.k *msgll;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               mux(becksoc, gymsoc, stmsoc, tpmsoc, target, my_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             print("INTMBR error: invalid msg type\n");
                                                                                     /* Determines which message was received */
                                                                                                                                                                                                                                                                                                                demux(msgl1, gvmsoc, stmsoc, tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (getfromlist(msgl1, &target, 2) != 2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("INTMBR error: get targethn");
                                                                                                                                                                                                  msg1 = st2list(buf," n@#");
                                                                                                                  action = in _msg_type(but);
                                                                                                                                                                       /* set up the top level list */
   /* close the input socket */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* Dispose of msg list */
                                                                                                                                                                                                                                                                                   Case INITPARAM:
                                                                                                                                                                                                                                                                                                                                                                                                                             case SNDINIPAR:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           removelist(msgl1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* end switch */
                                                                                                                                                                                                                                                           switch (action) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exis(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } /* end while */
                                  close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      /* end main */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1);
                                                                                                                                                                                                                                                                                                                                               bresk:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Presk:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            free(but);
```

msg.c = sr.zlas(cmp_dsta, #);

/* generate the initial status table message */
strcpy(header, "initiable");

msg = list2str(msgt2, header, "vn", "#"); msglen = strlen(msg); /* send the initial status table to stm */

smid = cornectUN(stmsoc);
if (writernsg(stmid, msg, msglen) < msglen) {
 print("VINTIMBR: initiable to stm failed.\n");
 print("VINTIMBR: initiable to stm failed.\n");
 exit("VINTIMBRENEWERSEREEDER");
 exit("VINTIMBRENEWERSEREEDER");</pre>

close(strnfd);

removelist(msgl2); free(msg);

/* convert token pool to list as only member */
msgD = sr2list(temp_data,"#");

/* generate the initial token pool message */ header = CALLOC(9 + 2, char); strcpy(header, "initipool");

msg = list2str(msg12, header, '\n', '#"); msglen = strien(msg);

/* send the initial token pool to tpm */
tymfd = connectUN(tymsoc);

if (writemsg(tpmfd, msg, msglen) < msglen) {
 print("vINTMBR: initpool to tpm failed.\n");
 print("V7\$
 print("V7\$
 exit(-1); }
</pre>

close(tpmfd);

removelist(msgl2); free(msg);

} /* end demux */

```
stmfd = connectUN(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 close(tpmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                close(stmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1); }
                                                                                                                                                                exit(-1); }
                                                                                                                                                                                                                                                                                                                                exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     exit(-1); }
char "backsoc, "gymsoc, "stmsoc, "tpmsoc, "target, "my_addr;
                             mux: assemble the initial parameter message from the existing
                                                        data base managers and send the msg to the back processor.
                                                                                                                                       void mux(backsoc, gymsoc, stmsoc, tpmsoc, target, my_addr)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if ((gvmsglen = readmsg(gvmfd, &gvmsg, "#")) < 0)
                                                                                                                                                                                                                                                                        msg(NODATAMSG + 1 + 10], *message;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           print("Integrate Mbr unix: read error - gvm\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            print("\INTMBR: viewregst to gvm failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (writemsg(gvmfd, msg, msglen) < msglen) (
                                                                                                                                                                                                                                                                                                                                                          gvmsglen, stmsglen, tymsglen;
                                                                                                                                                                                                                                               backfd, gvmfd, stmfd, tpmfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                           gvmsgl, *smsgl, *tpmsgl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * read the group view message */
                                                                                                                                                                                                                                                                                                    gymsg, *smsg, *tymsg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               gvmfd = connectUN(gvmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      gvmsg[gvmsglen] = NUIL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(msg,"viewreqst#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  stropy(msg, "statreqst#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        msglcn = strlen(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            msglen = strlen(msg);
                                                                                                                                                                                                                                                                                                                              gv, *st, *tp;
                                                                                                                                                                                                                                                                                                                                                                                      nessage_len;
                                                                                                                                                                                                                                                                                                                                                                                                                  msglen;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               close(gvmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                exif(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   exif(-1); )
                                                                                                                                                                                                                                                                                                                                Char
```

```
print("O7$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* convert the data base messages into the proper format */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if ((tpmsglen = readmsg(tpmfd, &tpmsg, "#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if ((stmsglen = readmsg(stmfd, &stmsg, "#")) < 0) |</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("Integrate Mbr unix: read error - stm\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("\UNTMBR: tokpreqst to tpm failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("Integrate Mbr unix: read error - tpm/n");
                                                                                                                  printf("VINTMBR: statredst to stm failed.\n");
if (writemsg(stmfd, msg, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (wniemsg(tpmfd, msg, msglen) < msglen)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* read the status table message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* read the token pool message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                gvmsgl = str2list(gvmsg,"\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           strnsgl = str2list(strnsg,"\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            true = connectUN(true connectUN(tr
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    tpmsg(tpmsglen) = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 strnsg[stmsglen] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strcpy(msg,"toldpreqst#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msglen = strlen(msg);
```

```
if (writemsg(backfd, message, message_len) < message_len) {
                            printf("Integrate Mbr unix: writernsg --- still no go\n");
                                                                                                                                                                                                 * clean up memory allocated */
                                                                                                                                                                                                                           removelist(gvmsgl);
                                                                                                                                                                                                                                                      removelist(stragl);
                                                                                                                                                                                                                                                                                 removelist(tpmsgl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end mux */
                                                                                                                                                                                                                                                                                                                                        free(message);
                                                                                                                                          close(backfd);
                                                                                                                                                                                                                                                                                                                                                                   free(gvmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                         ree(tpmsg);
                                                                                                                                                                                                                                                                                                                                                                                             free(strnsg);
                                                                                    exif(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       message = CALLOC((9 + 2*MAXLMTSIZE + stricn(gv) + stricn(st) + stricn(tp) + 5 + 11),
                                                                                                                                                                                                                                                                                                                                                                                           print("Integrate Mbr error: getfromlist gv\n");
                                                                                                                                                                                                                                                                                                                                                              print("Inegrate Mbr error: getfromlist tphn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                             * reserve temp storage for outgoing message */
                                                                                                                                                                                                                      print("Integrate Mbr error: getfromlist st\n");
                                                       if (geoffromlist(gyrmsgl, &gy, 2) == 0) {
                                                                                                                                                                                                                                                                                                                                     if (geofromlist(tymsgl, &tp, 2) == 0) {
                                                                                                                                                                                            if (getfromlist(struggl, &st, 2) = 0) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        message_len = strlen(message);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    strcpy(message, "initparam\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      backfd = connectUN(backsoc);
tymsgl = str2list(tymsg, "va#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* assemble the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     strcat(message,my_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* write the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 streat(nessage,target);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                stread(nessage,"@");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      stress(r)essage,"@");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            stream(message,"@");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcat(r) ressage," ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  streat(message,"#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           streat(message.gv);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         streat(raessage.tp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   streat(message,st);
                                                                                                                                      cxis(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                        exif(-1); }
                                                                                                                                                                                                                                                                               cxif(-1); }
```

JOIN PROCESSOR

Process Specification	•••••	152
Join Processor Code		153

```
Initiate Join for a join request message/token for p<sub>now</sub> at p<sub>i</sub>
1 while (true)
       if (p_{new} \notin ST_{Pi}, GV_{Pi})
2
3
4
5
6
         receive join request message or token for p
       end
       if (p_i = p_{host})
         send initiate agreement message to AgreeProcessor for page
         block until AgreeProcessor acknowledges end of processing
8
       else
           ST_{P_i}(p_{new}) \leftarrow JoinRequested
10
          if (join request message) /* p_n locates p and sends its join request */
             generate joinreq<sub>Pi</sub>(P<sub>new</sub>) token
11
12
          end
13
           add joinreq_{p_i}(p_{new}) to TokenPool(p_i)
14
          send joinreq token to cwnbr(p,)
15
       end
16 end
   end InitiateJoin
```

Figure A15 Processing of a Join Request Message / Token

```
printf("Usage: JoinProcessor soc myaddr strnsoc gymsoc tprnsoc agrsoc intsoc backsoc
                                                                                                                                                                                                                                                                                                                                                                                                       targetmember[MAXLMTSIZE], joinrequest[QUERYLEN+1],
                                                                                                                                                                                                                                                                                                                                                                     *initpbuf, *buf, *stbuf, *originator, request[NODATAMSG+1],
                                                                                                                                                                                                                                                                                                                                *intsoc, *backsoc, *frontsoc, *groupname, *sites, *tmp_buf,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  "myaddr, "stmsoc, "gymsoc, "tpmsoc, "agrsoc, "tinitpbuf,
                                                                                                                                                                                                                                                                                                                                                                                                                                              "initpmsgtype, "sitename, initgv[INITGVMSGLEN + 1],
                                                                                                                                                                                                                  gvmfd, stmfd, tpmfd, intfd, backfd, frontfd, initgvlen,
                                                                                                                                                                                       soc, newsoc, clen, msglen, msgtype, nsites, stmsglen,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        * Get socket file descriptors from command line argument.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              *token, updistsmsg[UPDTSTSMSGLEN+1];
                                                                                                                                                                                                                                                           i, foundmember, groupsize, c, j, on, countval;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 frontsoc groupmame siteaddrsSeparatedBy=\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       caller_addr,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          "msglist, "sitelist, "msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 myaddr is (ipaddr,front;back)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                = argv[5];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                =: atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         gvmsoc = argv[4];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  myaddr = argv[2];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     sockaddr un
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       stmsoc = argv(3);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                agrsoc = argv[6];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         backsoc = argv(8);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       intsoc = argv(7);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          *fileptr;
                                                                         *angv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (arrgc!= 12) {
  main(argc,argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tpmsoc
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    8
                                                                                                                                                                                                                                                                                                  char
                                                                           char
                                      Ħ.

    A group name has to be supplied as a command line argument.

                                                                                                                                              names for the agreement processor, group view manager, status
                                                                                                         * Description: - Uses one Unix domain socket, self address, and socket
                                                                                                                                                                                    table manager, token pool manager, commit processor, and
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          If a member of the target group is not found, an attempt to
                                                                                                                                                                                                                                                                                                                                                                                                                                          with /mp/groupname member instance is found. The file
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              the file on the next site from the command line argument
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        entered to receive and process the next join request/token.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   Starting with the first entry, a join request is sent to each
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     arched without a join,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    sent to integrate member and an infinite while loop is
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               read is made until all the sites are treated or the group

    1 (local site) or more ip addresses may be supplied.

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 - If join succeeds at any point, initial parameters are
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       until the group is joined or all entries are searched.
                                                                                                                                                                                                                     integrate member. Also receives front and back.
                                                                                                                                                                                                                                                                                                                                                                                                         Each is searched sequentially until one
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          the group is registered locally.
                                                                    * Algorithm: Fig. 5 of the gmp paper
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     is joined. If all sites have h
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /tmp/groupname is read.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           * Written by: Shridhar Shukla
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               David Pezdirtz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      15 Nov 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     int GerCountForloin();
                                    * JOINPROCESSOR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                void SendTlan2Agr();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                #include "gmputil.c"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         int InStatusTable();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    int CopyGVFile();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                int CountDown();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         int IsGroup();
```

```
targetmember[j] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("VOINPROCESSOR: group view file not found at %s. \n", sitename); ]
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        else { /* file found and copied, if found assumed to be in the correct format. */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          print("VOINPROCESSOR: si:. list parsing failed for sie %d\n", i);
                                                                                                                                                                                                                                                                                                        print("violNPROCESSOR: site list parsing failed or empty list.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       while ( (foundmember \rightleftharpoons FALSE) && (groupsize->0) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           while ( ((c = fgetc(fileptr)) != EOF) && ( c != \n'))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          c = fgetc(fileptr); /* to get rid of the \n after groupsize */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 while ( (foundmember == FALSF, && (\leftrightarrowi <= nsites) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (CopyGVFile(sitename, myaddr, groupname) ==0)
                                                                                                                                                                                                                                                              if ((nsites = listsize(sitelist)) == 0) { /* i must be >= 1 */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* get the next entry as the request target */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  fscanf(fileptr, "%d", &groupsize);
fscanf(fileptr, "%d", &groupsize); /* overwrite */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if (getfromlist(sitelist, &sitename, i) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          targetmember[j++] = c;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  fileptr = fopen(groupmanne, "r");
                                                                                                                                                                          sirclist = \operatorname{ar2list}(\operatorname{sites}, "=");
                                          groupmame = argv[10];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          foundmember = FALSE;
                                                                                      sites = argv[11]; }
  frontsoc = argv[9];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                               exif(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        i=0;
```

```
if ( (new soc = accept(soc, (struct sockaddr*) & caller_addr, & clen)) == -1) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if ( (ermo == EWO( !LDBLOCK) || (ermo == EINPROGRESS)) |
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            else { printf("vJOINPROCESSOR: initparam acupt entr');
                                                                                                                                                                                                                                                                                                                                                                                                                                                   while ( (foundmember \Longrightarrow FALSE) && (CountDown(& . ountval,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* Make soc nonblocking to enble count down while waiting */
                                                                                                                                                                                                                                                                                                                                                                                                             printf("vIOINPROCESSOR: join request to back failed.\n");
                                                                                                                                                                                                                                                                                                                                                                           if (writemsg(backfd, joinrequest, msglen) < msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ; /* no connections present */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      else { /* a connection is present */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 ioctl(soc, FIONBIO, (cher *) &con);
                                    strcat(joinrequest, targetmember);
strcpy(joinrequest, "joinreqstvn");
                                                                                                                                                                                                                                                                                                backfd = connectUN(backsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        countval = GetCountForJoin();
                                                                                                                                                                                                                                                              msglen = strlen(joinrequest);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         clen = sizeof(caller_addr);
                                                                                                            streat(joinrequest, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             on = NONBLOCKING:
                                                                                                                                                                                                                            /* send a join request */
                                                                                                                                              streat(joinrequest, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* end if newsoc */
                                                                      streat(joinrequest, "");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                COUNT_DOWN_STEP) != 0) ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     close(backfd);
```

* assemble a request */

```
\inf d = \operatorname{connectUN}(\operatorname{intsoc});
                                                                                                                        msglen = strlen(initpbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      initgylen = strlen(initgy);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            streat(initgv, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                         removelist(msglist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          streat(initgv, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                removelist(sitelist);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                               exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                     free(tinitpbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                         free(initpbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       close(gvmfd);
                                                                                                                                                                                                                                                                                                                                                                             close(intfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("VOINPROCESSOR: initparam expected something else
                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("vJOINPROCESSOR: iniparam PORT read error.\n");
                                                                                                                                                                                                                                                                                                                                                                                                       print("VOINPROCESSOR: msgtype persing failed.\n");
if ( (msglen=readmsg(newsoc,\&initpbuf,"#")) < 0) {
                                                                                                                                                                                                                                                                                  /* msg was read - check its type to be initiparam */
                                                                                                                                                                                                                                                                                                                                                                           if (getfromlist(msglist, &initpmsgtype, 1)=0) (
                                                                                                                                                                                      initipluf = CALLOC(strlen(initipluf) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (stremp(initpmsgtype, "initparam") != 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* end while foundmember is false & CountDown*/
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* end while foundmember is false & groupsize */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             octl(soc, FIONBIO, (char *) &con);
                                                                                                                                                                                                                                                                                                               msglist = str2list(tinitpbuf, "\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* Make soc blocking as before */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      else foundmember = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* end while foundmember is false & i++ */
                                                                                                                                                        initipbuf[msglen] = NULL;
                                                                                                                                                                                                                    strcpy(tinitpbuf,initpbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* end else newsoc = accept */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               on = BLOCKING:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   free(tinitpbuf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* end else CopyGVFile */
                                                                                              exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exis(-1):
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              rcvd'n");
```

```
if (fourdmember == TRUE) { /* send initial parameters to integrate member */

** no changes required to the initiparam mag revd from front earlier */
maglen = stren(init)but);
initid = cornectUN(intssc);
if (writerneg(initid, initipouf, maglen) < maglen) {
    printf("VOINPROCESSOR: initiparam mag send to integrate member failed\n");
    free(initipou);
    free(initipou);
    free(initipou);
    free(initipou);
    streat(initigo., "mitigo.ew\nO=1=");
    streat(initigo., "#);
    initigo.em = stren(initigo);
    grand(= cornectUN(gransoc);
    fif (writerneg(groundi, initigo.);
    printf("VOINPROCESSOR: initial group view to grom failed.\n");
    close(grunfid);
    freed else foundmember */
    removelist(sixelist);
```

```
print("vJOINPROCESSOR: group join request/token parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("VExecuteAgreement: status update to stm failed\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* send update status message to status table manager */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if ( writemsg(stmfd, updtstsmsg, msglen) < msglen) {</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         token = CALLOC(TOKENIMSGLEN + 1, char);
                                                                                                                                                                                                                                                                  SendThrn2Agr(agrsoc, "joinagree", originator);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* if joinreq msg -> generate joinregst token */
                                                                                                                                                                                         /* if I'm the host -> initiate joinagree token */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       token = CALLOC( strlen(bul) + 1, char);
  if (getfromlist(msg, &originator, 3) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                strcpy(token, "tokentoknynjoinregst");
                                                                                                                                                                                                                                                                                                                                            /* add joirneqst status to status table */
                                                                                                                                                                                                                              if (InGroup(gymsoc, myaddr) = 0)
                                                                                                                                                                                                                                                                                                                                                                                strcpy(updtstsmsg, "updstatus\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                       strcat(updistsmsg, "");
strcat(updistsmsg, "joinpendg");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (msgtype == JOINREQST)
                                                                                                                                                                                                                                                                                                                                                                                                                          streat(updistsmsg, originator);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        stmfd = connectUN(stmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   msglen = strlen(updtstsrmsg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       strcat(tolzen, originator);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   streat(updtstsmsg, "#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcat(token, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcpy(token, buf); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcat(token, "#"); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcat(token, " ");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        close(stmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               exit(-1); )
                                                                                                                exit(-1); }
print("VOINPROCESSOR: join req or token expected. rcvd => 1%sNn", bul);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("VOINPROCESSOR: unix read error for join request or token.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                     printf"\UOINPROCESSOR: unix accept error for join req / token.\n");
                                      * Element has become a member of the name group. Now, simply wait for
                                                                                                                                                                                                                                                                                                                                                                                if ((newsoc = accept(soc, (struct sockaddt*) &caller_addr, &clen)) < 0)(
                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* read join request from front or join token from agreement process */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if ((msgtype!=JOINREQST) && (msgtype!=TOKENTOKN)) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* only tokens rovd here are join tokens or joinrequests */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* get the originator of the request or subject of token

    join requests or tokens to arrive and process them.

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if ((msglen=readmsg(newsoc,&buf,"#")) < 0) {</pre>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tmp\_buf = CALLOC(strlen(bul) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msg = str2list(tmp\_buf, "\n \#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      msgtype = in msg_type(but);
                                                                                                                                                                                                                                                                                                         clen = sizeof(caller addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   buf[maglen] = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     strcpy(tmp_buf, buf);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       * (3rd field in both)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          cxit(-1); ]
```

close(newsoc);

exit(-1);)

while (TRUE) [

```
CopyGVFile: Returns a 0 if file not found at the site ip address sitename.
                                                                                                                                                                          print("\ProcessToken: tlen send to join process failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("VAgreement: token send to from failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                      if (writemsg(frontfd, token, msglen) < msglen) {
                                                                                                                  if (writemsg(tpmfd, token, msglen) < msglen) {
   /* add joinregst token to token pool */
                                                                                                                                                                                                                                                                                                                          /* send joinnegst token to cwnbr */
                                                                                                                                                                                                                                                                                                                                                                                frontid = connectUN(frontsoc);
                                                           pmfd = connectUN(tpmsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* and JOINPROCESSOR */
                               msglen = strlen(token);
                                                                                                                                                                                                                                                                                                                                                      msglen = strlen(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* end else InGroup */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* end while true */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               removelist(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      close(frontfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     free(trmp_but);
                                                                                                                                                                                                                                                                 close(tpmfd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exit(-1); }
                                                                                                                                                                                                         exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             free(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           free(bul);
```

Else returns a 1 after copying the file in the local directory

```
/*****************************
                                                                                                                                                                                                                                                                                    command[512], *ip_address, localaddr[MAXLMTSIZE+1], *myname;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("vCopyGVFile: Success, found %s, also known as %shn",
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    ip_address = (char*) inet_ntoa( *((struct in_addr*)( hptr->h_addr)));
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          bcopy((char *) & winaddr, (char *)hptr->h_addr, sizeof(inaddr)); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("vCopyGVFile: Sorry host %s not foundm", sitename);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if ((inaddr = inet_addr(sitename))!=INADDR_NONE) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("vCopyGVFile: my addr parsing failed.\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (getfromlist(myaddrlist, &myname, 1)!= 1) {
                                                                  int CopyGVFile(sitename, myaddr, groupname)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    hptr->h_name,hptr->h_aliases[0]);
                                                                                                         char *sitename, *myaddr, *groupname;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (hptr=gethostbyname(sitename))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         myaddrlist = str2list(localaddr, ";");
                                                                                                                                                                                                                                                                                                                                                         hostent hentry, *hptr;
with name as groupname.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      strcpy(localaddr, myaddr);
                                                                                                                                                                                                                                                                                                                                                                                                *myaddrlist;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* end else inaddr */
                                                                                                                                                                                                                                                                                                                           *fileptr;
                                                                                                                                                                                                                   copied;
                                                                                                                                                                                                                                                   inaddr:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   hptr = &chentry;
                                                                                                                                                                                                                                                      u_long
                                                                                                                                                                                                                                                                                                                        FILE
                                                                                                                                                                                                                                                                                                                                                               SPEC
                                                                                                                                                                                                                                                                                          Char
```

```
.달
                          sprintf(command, "rsh %s cat %s > %s", sitename, groupname, groupname);
                                                                                                                                                                                                                                                                                                 printf("VCopyGVFile: Could not rsh at site %s\n", sitename);
if (stromp(myname, ip_address) != 0) ( /* need to attempt copying */
                                                                                                                                                                                                                                                                       printf("vCopyGVFile: Could not change mode.\n");
                                                                                                                                                                                        sprintf(command, "chmod 777 %s", groupname);
                                                                                                                                                                                                                                             if (system(command) !=0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          fileptr = fopen(groupname, "r");
                                                                                if (system(command) != 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if (fgetc(fileptr)!≈ BOF)
                                                                                                                                                                                                                                                                                                                                                                                 } /* end else system */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           } /* end CopyGVFile */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    removehist(myaddrlist);
                                                                                                                                                                                                                                                                                                                             exit(-1); )
                                                                                                                                  copied=0;)
                                                                                                                                                                                                                                                                                                                                                                                                                                    } /* end if stremp */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                copied = 1;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     else copied = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           fclose(fileptr); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               else copied = 0;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        return(copied);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (fileptr) (
                                                                                                                                                                $
```

```
GetCountForJoin: Determines the wait before the join request is repeated.

(value returned times the COUNT_DOWN_STEP seconds)

int GetCountForJoin()

int next;

next = RESENDREQST;

return(next);

// end GetCountForJoin */
```

DATABASE MANAGERS

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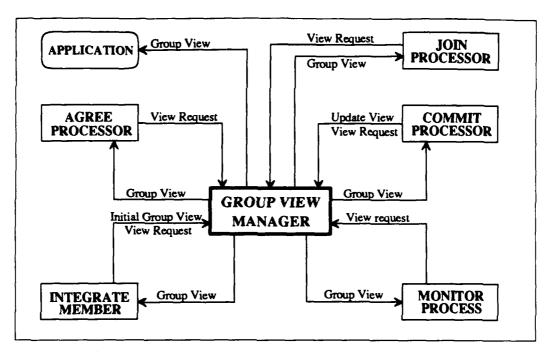


Figure A16 Group View Manager - Process Dependencies

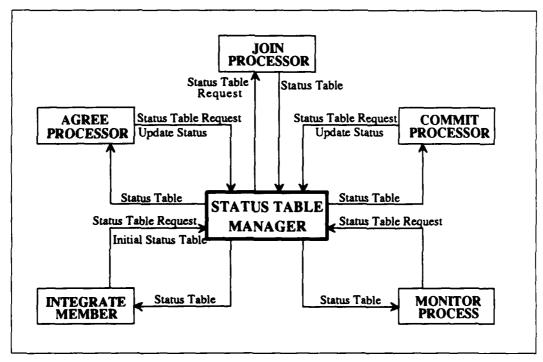


Figure A17 Status Table Manager - Process Dependencies

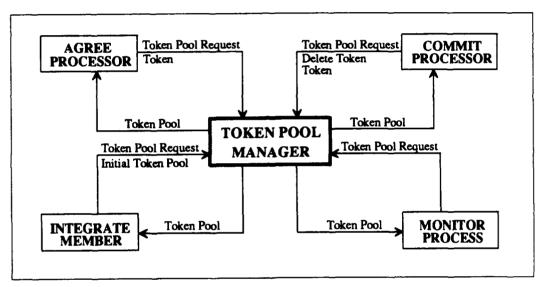


Figure A18 Token Pool Manager - Process Dependencies

```
'msgtype, "buf, "tmp, "grp_name, "appsoc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              tmp = CALLOC(HEADERSIZE + 4 + strlen(argv[2]), char);
                                                                                                                                                                                                      socnewsoc,clen,msglen, appfd;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     initialize(&head, init_element, &view_nmbr, &view_size);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /* initialize the group view for a single member */
                                                                                                                                                                                                                                                                                                                   "head = NULL;
                                                                                                                                                                                                                                                                                                                                                              view_nmbr = 0;
                                                                                                                                                                                                                                                                                                                                                                                     riew_size = 1;
                                                                                                                                                                                                                                                                                              init element;
                                                                                                                                                                                                                                                 caller addr;
                                                                                                                                                                                                                                                                                                                                          msgll;
                                                                                                                                                                                                                                action:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strcpy(tmp,"initheadt\n()=1=");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                init_element = str2list(tmp,"\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 removelist(init_element);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           grp_name = argv[4]; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                    soc = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          streat(unp,argv[2]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      appsoc = argv[3];
                                                                                                                                                                                                                                                    struct sockaddr_un
                                                                                                                                       *argv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                if(argc == 5){
                                                                                            main(argc,argv)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                            Main:
                                                                                                                                                                                                                                                                        char
                                                                                                                                                                                                                                                                                                                  li k
                                                                                                                                                                                                                                                                                                                                       link
                                                                                                                                                                                                                                                                                              li k
                                                                                                                                                                                                                                                                                                                                                             . E . E
                                                                                                                                      char
                                                                                                                                                                                                                                                                                                                    Waits for a connection and then reads a message. Depending on the
                                                                                                                                                                                    message type it executes one particular action. Dumps the group view
                                                                                                                                                                                                         * to a group file and sends the group view to the application socket on
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* possible update actions */
                                                                                                                                                                                                                                                                            * USACE: gvm soc initial_element appsoc group_name
                                                                                                                                                                                                                                every update to the group view.
                            * Group View Manager (GVM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     process_request();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               process_update();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                save_grp_view();
                                                                                            * Author: David Pezdirtz
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            remove_view();

    Version: 06 APR 1993

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           create_msg();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           void show_grp_view();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       mittalize();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            typedef char *buffer,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              #include "msgutil.c."
                                                                                                                                          DESCRIPTION:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  #include "socutile"
                                                                                                                                                                                                                                                                                                                                                                                                                                                        Finclude "grmp.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                <u>$</u>
                                                                                                                                                                                                                                                                                                                                                                                          Declarations
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              Adefine ADD
```

Adefine DEL

Void

Void

Void

Á

Void , Q Void

Š.

buf[msglen] = NULL; ** Determines which message was received */ action = in_msg_type(buf); ** set up the top level list */

if ((msglen = readmsg(newsoc, &buf, "#")) < 0) {

print("GVM: read error\n");

exit(-1); }

magl = st2list(buf, "n#");

switch (action) {
 case VIEWREQST:
 process_request(newsoc, head, view_nmbr, view_size);
 head:

case UPDATVIEW:

process_update(&head, msgli, &view_nmbr, &view_size); save_gp_view(gp_name, head, view_nmbr, view_size);

appid = cornectUN(appsoc); process_request(appid, head, view_nmbr, view_size);

close(appsoc);

case INTIGNIEW:

```
save_grp_view(grp_name, head, view_nmbr, view_size);
                                                                                                                                                                                                     printf("GVM error: invalid msg type %shr", msgtype);
initialize(&head, msgl1, &view_nmbr, &view_size);
                                                                            process_request(appfd, head, view_nmbr, view_size);
                                                   appfd = connectUN(appsoc);
                                                                                                                                                                                                                                                                                                                                                            /* Dispose of msg list */
                                                                                                                                                                                                                                                                                                                                                                                       removelist(msgl1);
                                                                                                                                                                                                                                                                                                             } /* end switch */
                                                                                                   close(appsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   } /* end while */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                   close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     } /* end main */
                                                                                                                                                                                                                                                          exit(-1);
                                                                                                                              bresk;
                                                                                                                                                                                                                                                                                                                                                                                                                free(but);
                                                                                                                                                                               default
```

```
print("GVM process_update error: getfromlist element failedn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("GVM error: deleted last group member\n");
                                 if ((getfromlist(msgl2, &element, 2)) == 0) {
                                                                                                                                                                                                                                            *view_size = ++*view_size;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           *view_nmbr = ++*view_nmbr;
                                                                                                                                                                                                                                                                                                                                                                             *view_size = -*view_size;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* end process_update */
                                                                                                                                                                                                                                                                                                                                                                                                                                if (*view_size < 1) {
                                                                                                                                                                                                                   add(head,element);
                                                                                                                                                                                                                                                                                                                                                  del(head,element);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           removelist(msgl2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } /* end switch */
                                                                                                                                                               switch (action) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                        case ADD:
                                                                                                                                                                                                                                                                                                                         case DEL:
                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       free(trapst);
                                                                                                                                                                                                                                                                           ger.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    default:
                                                                                                                                                           /*********************
print("GVM process_update error: getfromlist(1)\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 print("GVM process_update error: getfromlist(2)\n");
                                 process_update: process the update group view message
                                                                                                                                                                                          void process_update(head,msgl1,view_nmbr,view_size)
                                                                                 usage: process_update(link *head, char *msgl1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if ( (geofromlist(msg/2, &request, 1)) = 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ( (getfromlist(msgl1, &request, 2)) = 0 ) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        trqst = CALLOC(strlen(request) + 1, char);
                                                                                                            head - ptr to the group view linked list
                                                                                                                                                                                                                                                                                                                                                  *request, *element, *uqst;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if (stremp(request,"add") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   if (stremp(request, "del") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                               action = 0; /* set for default */
                                                                                                                                                                                                                                                                    *view_nmbr,*view_size;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      msg2 = str2iist(trqst," #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       stropy(traps, request);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* get the action */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                action = ADD;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             action = DEL;
                                                                                                                                                                                                                                                                                                                         action,
                                                                                                                                                                                                                                                                                                                                                                            *msg[2;
                                                                                                                                                                                                                                         link *msgll;
                                                                                                                                                                                                                 link **head;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         cxif(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
```

```
/* check for empty list */
                                                 printf("GVM process_request error: writemsg\n");
                                                                                                                                                                                                                                                                                                  add: add a node to the end of the current group view.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* parse to end of list */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tmp->data = CALLOC(strlen(element) + 1, char);
                          if ((writemsg(soc,msg,msglen)) != msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       while (ptr-ynext!= NULL) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         strcpy(tmp->data,element);
                                                                                                                                                                                                                           /* end process_request */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         tmp = CALLOC(1, link);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   ptr = ptr->next; }
                                                                                                                                                                                                                                                                                                                                                                         void add(head, element)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if (*head == NULL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              } /* end else head */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 mp->next = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ptr->next = tmp;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                           link *tmp, *ptr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         *head = tmp;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       ptr = *head;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } /* end add */
                                                                                                                                                                                                                                                                                                                                                                                                                          char *element;
                                                                                                                                                                          free(header);
                                                                                                   exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                  link **head;
                                                                                                                                                  free(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  else (
msg = CALLOC((9 + 2*MAXNUM + 3 + size*(MAXLMTSIZE + 1) + 1), char);
                          process_request: assemble the list into a string and write the message to
                                                                                                                          groupview" | \n | view # | = | view size ! = belement| = belement| ... | # |
                                                                                                                                                                                                                                                                                                                                                                                                                                                  header = CALLOC((9 + 2*IMAXNUIM + 3 + 1), char);
                                                                                                                                                                             world process_request(soc, view, nmbr, size)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              msg = list2str(view, header, "=", "=");
                                                                                                                                                                                                                                                                                                                                                  char temp[MAXNUM+1];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           strcpy(header, "groupview");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* create the msg header */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  sprintf(temp,"%i", nmbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               sprintf(temp,"%i", size);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* create the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               msglen = strlen(msg);
                                                                                                                                                                                                                                                                                                                                                                            char *header, *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            streat(header,temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           streat(header,temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  streat(header,"\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          streat(header,"=");
                                                        the socket
                                                                                                     output msg format:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              streat(msg,"#");
                                                                                                                                                                                                                                                                            nmbr, size;
                                                                                                                                                                                                                                                                                                                                                                                                     int msglen;
                                                                                                                                                                                                                                                      View
                                                                                                                                                                                                                               ပ္တ
```

```
/* otherwise remove node from list */
                                                                                                                                                                                     /* if so, reset the head ptr */
                                             printf("GVM del element: 1%st not in list\n", element);
  /* ERROR: requested delete not in list */
                                                                                                                                        /* check for delete of 1st element */
                                                                                                                                                                                                                                                                              /* free up the storage used */
                                                                                                                                                                                                                                     last->next = ptr->next;
                       if (found == FALSE) [
                                                                                                                                                                                       *head = ptr->next;
                                                                                                                                                              if (last = NULL)
                                                                                                                                                                                                                                                                                                    free(ptr->dat:);
                                                                                                                                                                                                                                                                                                                                                                      } /* end del */
                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                            free(ptr);
del: search for the specified element and delete the node from the list.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           while ( (found = FALSE) && (ptr != NUIL)) (
                                                                                                                 2. element not found in list
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("GVM del element: empty list\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (strcmp(ptr->data, element) = 0)
                                                                                           1. empty list
                                               Exit on error conditions:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } /* end while found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  ptr = ptr->next; }
                                                                                                                                                                                       void del(head_element)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              found = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (pt = NULL)
                                                                                                                                                                                                                                                                                                                                                                       found = FALSE;
                                                                                                                                                                                                                                                                                                      link *pu, *last;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             bast = ptr;
                                                                                                                                                                                                                                                                                                                                                                                                                                           bas = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                    ptr = *head;
                                                                                                                                                                                                                                  char *element;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exis(-1); }
                                                                                                                                                                                                            link **head;
                                                                                                                                                                                                                                                                                                                             int found;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        - Se
```

```
while ( (getfromlist(msgl, &data, next_element)) > 0) {
                                                                                                                                                         next_element = ++next_element; }
                                                      next_eterment = 3;
    *size = atoi(data);
                                                                                                                                                                                                                                                                                                                                       removelist(msgl);
                                                                                                                                add(head,data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(view->data);
                                                                                                                                                                                                                                                                                                                                                                  free(tmp_data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (view->next)
                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  link *view;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       free(view);
initialize: initialize the group view. Delete and removes existing list
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           print("GVM initialize error: invalid format bhr");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         print("GVM initialize error: invalid format c/n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("GVM initialize error: invalid format a\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      tmp_data = CALLOC(strlen(data) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if ( (getfromlist(msgl, &data, 2)) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     if ( (getfromlist(msgl, &data, 1)) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                            if ((getfromlist(list, &data, 2)) = 0) {
                                                                                                      void initialize(head, list, nmbr, size)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  msgl = str2list(tmp_data,"=#");
                                                                                                                                                                                                                                                                                      "data, "ump_data;
                                                                                                                                                                                                                                                                                                                                                                remove_view(*head);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strcpy(tmp_data, data);
                                                                                                                                                                                                                                                              next element;
                                                                                                                                                                                                                                                                                                                                      if (*head!= NULL) {
                                                                                                                                                                                                                                                                                                                                                                                       *head = NULL; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                *nmbr = atoi(data);
                                                                                                                                                         *mmbr, *size;
                                                                                                                                link **head *list;
                                                                                                                                                                                                                                       *msgl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          exid(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     exif(-1); }
                                                                                                                                                                                                                                       直
```

```
remove_view: Deallocates the space used by the groupwiew manager.
                       printf("GVM initialize error: invalid formath");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   remove_view(view->next);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* and remove view */
                                                                                                                                                                                                                                                                                                                                                                                                                      void remove_view(view)
if (next_element < 4)
                                                                                                                                                                                                         /* end initialize */
```

```
if ( ( fprintf(fd, "%s", msg) ) != msglen) {
                                                                                                                                                                                                                                                                                                                                    strcpy(chrnod, "chmod -f 666");
                                                                                                                                                                                                                                                                                    /* change the access codes */
                                                                                                                                                                                                                                                                                                                                                              streat(chmod, grp_name);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           } /* end save_grp_view */
                                                                                                                                                        if (\text{fclose}(\text{id}) = \text{EOF}) (
                                                                                                                              /* close the file */
                                                                                                                                                                                                                                                                                                                                                                                                            system(chmod);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          free(chmod);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            free(header);
                                                                               exit(-1); }
                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 free(msg);
msg = CALLOC((2*MAXNUM + 2 + size*(MAXLMTSIZE + 1) + 1), char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              save_grp_view: creatics/overwrites the group view file in /tmp directory
                                                     filename is passed as cmd line arg on invocation of gvm
                                                                                                      world save_grp_view(grp_name, head_ptr, nmbr, size)
                                                                                                                                                                                                                                                                                                                                                                                                            header = CALLOC((2*MAXNUM+2+1), char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       print("GVM save_grp_view error: file open'n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            msg = list2str(head_ptr, header, "\n", "\n");
                                                                                                                                                                                                                                                        temp[MAXNUM+1];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             id = fopen(grp_rame,"w");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         * create the msg header */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                sprind(temp, "%i", nmbr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        sprintf(temp,"%i", size);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* create the message */
                                                                                                                                                                                                                                                                                header, *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         stropy(header,temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     msglen = strlen(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     streat(header,temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   streat(header, "\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* open the file */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              if(id = NULL)
                                                                                                                              char *grp_name;
                                                                                                                                                        *head_ptr;
                                                                                                                                                                             nmbr, size;
                                                                                                                                                                                                                                                                                                                                                            *chmod;
                                                                                                                                                                                                                                                                                                             msglen;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); |
                                                                                                                                                                                                                                                                                                                                  FILE
                                                                                                                                                                                                                                                            char
                                                                                                                                                                                                                                                                                      Ç
                                                                                                                                                      Ħ
```

```
chmod = CALLOC(5 + 2 + 3 + 3 + strlen(grp_rame), char);
                                                                                                                                                                                          printf("GVM save_grp_view error. file c'ose\n");
printf("GVM save_grp_view error: printfvn");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* de-allocate all of the temp storage */
```

```
if ( (newsoc = accept(soc,(struct sockaddt**) & callor_addt, & cclen)) < 0) |
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           soc,newsoc,clen,msglen;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ( (msglen = readmsg(newsoc, \&buf, "#")) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* Accept connection request from client */
                                                                                                                                                                                                                                                 *head = NULL;
                                                                                                                                                                                                                                                                                           group_size = 0;
                                                                                                                                                                                                          caller_addr,
                                                                                                                                                                                                                                                                                                                                                                                            printf("STM usage error: stm soc\n");
                                                                                                                                                                                                                                                                        msgl1;
                                                                                                                                                                                          action:
                                                                                                                                                                                                                                 ðuf.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("STM: accept error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            printf("STM: read error\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                        soc = atoi(argv[1]); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* Read message */
                                                                                                                                                                                                           struct sockaddr un
                                                                                                                            *argv[];
                                                                                                                                                                                                                                                                                                                                   if(argc = 2) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                            while (TRUE)
                                                                                   main(argc,argv)
                                                                                                          argc;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                       Main:
                                                                                                                                                                                                                                 char
                                                                                                                                                                                                                                                  <u>li</u>
                                                                                                                                                                                                                                                                      li k
                                                                                                                           char
                                                                                                                                                                     Ħ.
                                                                                                                                                                                                                                                                     *******************
                                                                                                                                                                                                                                                                                                                                                     * message type it executes one particul... action. Will return a message
                                                                                                                                             9 message. Depending on the
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* possible update actions, */
```

#inchude "msgutill.c"

Winchide "gmp.h"

Declarations

Finchate "socutile"

Mdefine ERROR 0

Mefine ADD

Adefine UPD Adefine DEL

process_request(); process_update();

mittalize();

Void Void Ş

create_msg();

Ď Ş Ş

typedef char *buffer,

remove_table();

* STATUS TABLE MANAGER (STM)

Waits for a correction and then re

• DESCRIPTION:

* Author: David Pezdirtz Vorsion: 06 APR 1993

* with size = 0 if empty list.

• USAGE: stm soc

```
· 一个,我们是我们的,我们的,我们的,我们的的,我们的,我们的,我们的,我们的,我们们的,我们们的,我们们的,我们们的,我们们的,我们们的,我们们的,我们们的
                                                                                                                                                                                                                                                                                                                                                                           "target, "element, "new_status, "current_lgt, "temp_data;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   printf("STM process_update error: getfromlist(1)a\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  printf("STM process_update error: getfromlist(1)6\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("STM process_update error: getfromlist(2)\n");
                                   process_update; process the update group view message
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if ( (getfromlist(msgl2, &new_status, 2)) = 0 ) {
                                                                                            usage: process_update(link *head, char *msgl1)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                       if ((getfromlist(msgl1, &ckernent, 2)) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if ((getfromlist(msgl2, &target, 1)) == 0) {
                                                                                                                                                                                    void process_update(head, msg11, table_size)
                                                                                                                            head - ptr to the group view linked list
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           target = CALLOC(strien(element), char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (stremp(new_status,"delstatus") == 0)
                                                                                                                                                                                                                                                                                                                                                                                                         *msgl2, *ptr, *msgl3, *last;
                                                                                                                                                                                                                                                                                                                                              action, found = FALSE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        msg12 = str2list(target," #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             " check for delete status */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           strcpy(target,element);
                                                                                                                                                                                                                                                                                *table_size;
                                                                                                                                                                                                                                                  *msgll;
                                                                                                                                                                                                                    **head;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           action = DEL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      action = UPD;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     exit(-1); }
                                                                                                                                                                                                                      真
                                                                                                                                                                                                                                                  直
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  process_update(&head, msgl1, &group_size);
                                                                                                                                                                                                                                                                                                             process_request(newsoc, head, group_size);
                                                            /* Determines which message was received */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      printf("STM error: invalid msg type\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            initialize(&head, msgl1, &group_size);
                                                                                            action = in _msg_type(but);
                                                                                                                                                    /* set up the top level list */
                                                                                                                                                                                    magit = str2list(buf, "n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* Dispose of msg list */
buf[msglcn] = NULL;
                                                                                                                                                                                                                                                                             CASE STATREOST:
                                                                                                                                                                                                                                                                                                                                                                                                                                   case UPDSTATUS:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             CASE INITITABLE:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     removelist(msgl1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* end switch */
                                                                                                                                                                                                                                                  switch (action) [
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             } /* end while */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 close(newsoc);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* cnd main */
```

break;

free(bud);

E SE

```
printf("STM error: attempt to delete non-existant element'n");
                                                                                                                                                                                                                                                                              last->next = ptr->next;/* otherwise remove node from list */
                                                                                                                                                                             /* check for delete of 1st element */
                                                                                                                                                                                                                                                                                                                                   /* free up the storage used */
                                                                           *table_size = ++*table_size;
                                                                                                                                                                                                                                                                                                                                                                                                                                        "table size = -- "table_size;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           strcpy(ptr->data, element);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* end process_update */
                                                                                                                                                                                                                                 *head = ptr->next;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                if (*table_size < 1) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       "head = NULL; )
                                                   add(head,element);
                                                                                                                                                                                                      if (last = NULL)
                                                                                                                                                                                                                                                                                                                                                             free(ptr->data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    removelist(msgl2);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* end switch */
switch (action) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     case ERROR.
                                                                                                                                                                                                                                                                                                                                                                                      free(ptr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  case UPD:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  exit(-1);
                        case ADD:
                                                                                                                                                      case DEL:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(target);
                                                                                                      bresk;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   bresk;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  default:
                                                                                                                                                                                                                                                            <u>ه</u>
                                                                                                                                                                                                                                                                                   print("STM process_update error: getfromlist(2)\n");
print("V/SSSSSSSSSSSSSSSSSSSSSSSSSSSSSS");
                                                                                                                             temp_data = CALLOC(MAXLMTSIZE + 9 + 1, char);
                                                                                                                                                                                                                                                            if ( (getfrombst(msgl3, &current_tgt, 1)) == 0) {
                                                                                                    while ((ptr != NULL) && (found == FALSE)) {
                                                                                                                                                                                                                                                                                                                                                                                         if (stremp(current_tgt, target) = 0)
                                                                                                                                                                                                          msgl3 = str2list(temp_data,"");
    /* search for the proper target */
                                                                                                                                                       strcpy(temp_data, ptr->data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        } /* end while ptr & found */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (found = FALSE) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  action = ERROR;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               pt = pt->next; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               removelist(msgl3);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (action != DEL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* end if found */
                                                                                                                                                                                                                                                                                                                                                                                                                  found = TRUE;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     action = ADD;
```

free(temp_data);

bast = ptr.

exit(-1); }

ptr = "head; has = NULL; /* if so, reset the head ptr */

```
add: add a node to the end of the current group view.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      tmp->data = CALLOC(strlen(element) + 1, char);
                              print("STM process_request error: writemsg");
    if ( (writemsg(soc, msg, msglen)) != msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* parse to end of list */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       while (ptr->next != NULL) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               strcpy(tmp->data, element);
                                                                                                                                                                                                                     /* end process_request */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          tmp=CALLOC(1, link);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* check for empty list */
                                                                                                                                                                                                                                                                                                                                                                                  void add(head, element)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* end else head */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ptr = ptr->next; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         tmp->next = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (*head = NULL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        ptr->next = tmp;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          link *tmp, *ptr;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              *head = tmp;
                                                                                                                                                                                                                                                                                                                                                                                                                                   char *element;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     ptr = *head;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ) /* end add */
                                                                                                                                                                                                                                                                                                                                                                                                            **head;
                                                                                                                                                                free(header);
                                                                                    exit(-1); }
                                                                                                                                         free(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              eke |
                                                                                                                                                                                                               /********************************
msg = CALLOC((9 + MAXNUM + 2 + size*(MAXLMTSIZE + 9 + 1) + 1), char);
                              process_request: assemble the list into a string and write the message to
                                                                                                                                                                 "statusabi" | Yn | table size | = leternentkplstatus| = leternent| ... | # |
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             header = CALLOC((9 + MAXNVIM + 2 + 1), char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           msg = list2str(table, header, "=", "=");
                                                                                                                                                                                                                       ******************
                                                                                                                                                                                                                                                 world process_request(soc, table, size)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* reserve memory for headerl */
                                                                                                                                                                                                                                                                                                                                                                                                          temp[MAXNUM+1];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 * reserve memory for Imsgl */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               /* create the mag header */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         stropy(header,"statustbi");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     sprintf(temp,"%i", size);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* create the message */
                                                                                                                                                                                                                                                                                                                                                                                                                                    *header, *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     msglon = strien(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  streat(header, temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   streat(header,"\n");
                                                                                                              output msg format.
                                                          the socket
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                streat(msg."#");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 msglen;
                                                                                                                                                                                                                                                                                                    S.
```

```
**********************
                                                                                                                                                                                                                                                                              remove_table: Deallocates the space used by the groupview manager.
                        if ((next_element - 2) < *size) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 remove_table(table->next);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                } /* end remove_table */
                                                                                                                                                                                                                                                                                                                                                  void remove_table(table)
                                                                                                                removelist(msgl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            free(table->data);
                                                                                                                                                                                                                                                                                                                                                                                                                                         if (table->next)
                                                                     exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                     link *table;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  free(table);
                                                                                                                                       free(tdata);
                                                                                                                                                                                     } /* end
initialize: initialize the group view. Delete and removes existing list.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            while ( (getfromliss(msgl, &data, next_element)) > 0) {
                                                                                                                                                                                                                                                                                                                                                                                              print("STM initialize error: invalid format a\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         print("STM initialize error: invalid format bhr");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    idata = CALLOC(stricn(data) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if ( (geoffromlist(msgl, &cdata, 1)) == 0) {
                                                                                                                                                                                                                                                                                                                                                                        if ((getfromlist(list, &data, 2)) = 0)
                                                                        ****************
                                                                                            void initialize(head, list, size)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         msgl = sr2list(data,"=#");
                                                                                                                                                                                                                                                                                                     remove_table(*head);
                                                                                                                                                                                                              next element
                                                                                                                                                                                                                                *data, *udata;
                                                                                                                                                                                                                                                                              if ("head!= NULL) i
                                                                                                                                                                                                                                                                                                                          *head = NULL; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        next_element++;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                next_element = 2;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             strcpy(tdata, data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            } /* end while */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     *size = atoi(data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  add(head,data);
                                                                                                                   ink **head, *list;
                                                                                                                                                                                       *msgl;
                                                                                                                                                                                                                                                                                                                                                                                                                                           exis(-1); ]
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       exit(-1); )
                                                                                                                                          III SZZC.
                                                                                                                                                                                                                                  cke
                                                                                                                                                                                        ž
```

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<sup></sup>
                                                        if ( (newsoc = accept(soc, (struct sockaddt*) & caller_addt, & clen)) < 0) {
                                                                                                                                                                                                                                                                                                                                                                                                        soc, new soc, clen, msglen;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            /* Accept connection request from client */
                                                                                                                                                                                                                                                     pool_size = 0;
                                                                                                                                                                                             caller addr;
                                                                                                                                                                                                              *buf, *data;
                                                                                                                                                                                                                                                                                                                                                                                    printf("TPM usage error: tpm soch");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    printf("TPM unix: accept error\n");
                                                                                                                                                                                                                                 *msgll;
                                                                                                                                                                           action;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             clen = sizeof(caller_addr);
                                                                                                                                                                                                                                                                                                                                                  soc = atoi(argv[1]); }
                                                                                                                                                                                           struct sockaddr_un
                                                                                                                 *argv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                while (TRUE) (
                                                                                                                                                                                                                                                                                                                              if(argc = 2) {
                                                                             main(argc,argv)
                                                                                                 argc;
                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                         link *ptr;
                   Main:
                                                                                                                                                                                                              char
                                                                                                                                                                                                                                Waits for a connection and then reads a message. Depending on the
                                                                                                                                                     * message type it executes one particular action.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 *head = NULL, *tail = NULL;
                 * TOKEN POOL MANAGER (TPM)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                 process_request();
                                                                         * Author: David Pezdirtz

    Version: 06 APR 1993

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          remove_table();
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               imitialize();
                                                                                                                                                                                        * USAGE: upm soc
                                                                                                                                                                                                                                                                                                                                                                                                                          typedef char *buffer;
                                                                                                                                                                                                                                                                                                                                                                                    #include "gmputil.c"
                                                                                                               • DESCRIPTION:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             Strip()
                                                                                                                                                                                                                                                                                                                                                                  Finclude "gmp.h"
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        <u>a</u>
                                                                                                                                                                                                                                                                                                            Declarations
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    Void
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                ğ
                                                                                                                                                                                                                                                                                                                                                                                                                                                               Į,
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 Ž
```

exit(-1); }

```
print("TPM initialize error: invalid format (b)\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    print("TPM initialize error: invalid format (a)\n");
                  if ( (msglen = readmsg(newsoc, \&but, "#")) < 0) {
                                                                                                                                                                                  /* Determines which message was received */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if ( (geofromlist(msg11, &data, 2)) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                              if ( (getfromlist(msg11, &data, 2)) == 0) {
                                       print("TPM PORT unix: read error\n");
                                                                                                                                                                                                                                                                                                                                                                       process_request(newsoc, pool_size);
                                                                                                                                                                                                           action = in mag_type(bul);
                                                                                                                                                                                                                                                       /* set up the top level list */
                                                                                                                                                                                                                                                                            msg1] = sr2list(buf,"\n#");
                                                                                                                                                                                                                                                                                                                                                                                                                                         case TOKENTOKN:
                                                                                                                                                                                                                                                                                                                                              case TOKPREQST:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         case DELTTOKEN:
                                                                                                                                   buf[msglcn] = NULL;
* Read message */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         pool_size++;
                                                                                                                                                                                                                                                                                                                          switch (action) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       pool_size-;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     exis(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  add(data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  del(data);
                                                                                        exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             break:
                                                                                                                                                                                                                                                                                                                                                                                               break;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 bresk:
```

```
**************************
                                                                                                                                                                                                          /* check for empty list */
                                                                                                                                                                                                                                                                                                                                                                                                                                           tmp->data = CALLOC(strlen(element) + 1, char);
                                                                                                                                                         add: add a node to the end of the current table view.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                        strcpy(tmp->data, element);
                                                  /* end process_request */
                                                                                                                                                                                                                                                                                                                                                                                          tmp = CALLOC(1, link);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (head = NULL) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               mp->next = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       tail->next = tmp;
                                                                                                                                                                                                                                                                                                                                      link *tmp, *ptr;
                                                                                                                                                                                                                                    void add(element)
                                                                                                                                                                                                                                                              char *element;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           head = tmp;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   tail = tmp; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                tail = tmp; }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    } /* end add */
free(header);
                                                                                                                                                       msg = CALLOC((9 + MAXNUM + 2 + size*(MAXLMTSIZE + 9 + 1) + 1), char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  "notempool" Natsizel = Noteen typel sp Subji sp tonigint sp l = 1 ... | # |
                                                                                                                                                                                                                                                                                                                                                                                                                  header = CALLOC((9 + MAXNUM + 2 + 1), char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          printf("TPM process_request error: writemsg");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 if ( (writernsg(soc, msg, msglen)) != msglen) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    msg = list2str(head, header, "=", "=");
                                                                                                                                                                                                                                                                                                                                                                                          /* reserve memory for headerl */
                                                                                                                                                                                                                                                                                    emp[MAXNUM+1];
                                                                                                                                                         ************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                         /* reserve memory for Imsgl */
                                                                                                                                                                                   void process_request(soc, size)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          strcpy(header, "tokenpool");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* create the msg header */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               sprintf(temp, "%i", size);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           /* create the message */
                                                                                                                                                                                                                                                                                                                  *header, *msg;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  msglen = strien(msg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         streat(header, temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      streat(header, "\n");
                                                  output msg format:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcat(msg,"#");
                                                                                                                                                                                                                                                                                                                                         msglen;
   Socker
                                                                                                                                                                                                                                 .
                                                                                                                                                                                                                ಕ್ಷ
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exis(-1); }
                                                                                                                                                                                                                                                                                       that.
```

free(msg);

process_request: assemble the list into a string and write the message to the

del: debee a node from the current token pool. Searches the token pool for the volcen that matches the data element passed. Ignores the originator /* compare the desired data to the current node's data */ /* strip the originator field from the stored tokens */ while ((found == FALSE) && (ptr != NULL)) { if $(sucmp(data, cur_data) == 0)$ field for comparison purposes. /* search for the proper status */ } /* end while found & ptr */ cur_data = strip(ptr->data); /* strip off the originator */ link *per, *last = NULL; char "data, "cur_data; found = FALSE; ptr = ptr->next; } data = strip(element); found = TRUE; free(cur_data); void del(element) last = ptr; char *element; ptr = head; free(data); - Se

```
/* otherwise remove node from list */
                                                                              /* if so, reset the head ptr */
                                                   printf("TPM delete token: token 1%sl not in list\n", element);
/* ERROR: requested delete not in list */
                                                                                                                                                                                                                                                                                                                                    /* check for delete of last element */
                                                                                                                                                                  /* check for delete of 1st element */
                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* free up the storage used */
                                                                                                                                                                                                                                                                                 last->next = ptr->next;
                                                                                                                                                                                                                                                                                                                                                               if (ptr->next == NULL)
                           if (found = FALSE) {
                                                                                                                                                                                                                            head = ptr->next;
                                                                                                                                                                                             if (last = NULL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                              free(ptr->data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               } /* end del */
                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                              tail = last;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           free(ptr.);
```

```
while ( (getfromlist(msgl, &celement, next_element)) > 0) {
                                                                                      /* add all tokens in list to local database */
   /* set the offset into the token pool list */
                                                                                                                                                                          next element++;
                                next element = 2;
                                                                                                                                              add(element);
                                                                                                                                                                                                                                                                                                                                                                        exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                          free(tdata);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    free(table);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    link *table;
initialize: initialize the table view. Delete and removes existing list.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* convert the token pool to a list of pool size & tokens */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("TPM initialize error: invalid format (b)\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("TPM: tialize error: invalid format (a)\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             idata = CALLOC(strict(element) + 1, char);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ( (getfromlist(msgl, &celanont, 1)) == 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if ( (getfromlist(list, &element, 2)) = 0) {
                                                                                                                                                                                                                                                                                                                                                                        * remove old list (if any) */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* get the token pool size */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            msgl = str2list(idata,"=#");
                                                                                                                                                                                                                                                                                                                   *element, *tdata;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     /* copy the token pool */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                /* get the token pool */
                                                                                                                                                                                                                                                                                   next element;
                                                                                                                                                                                                                                                                                                                                                                                                                             remove_table(head);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              strcpy(stata, element);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       *size = atoi(element);
                                                                                                                word initialize(list, size)
                                                                                                                                                                                                                                                                                                                                                                                                  if (head!=NULL) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                       head = NULL; }
                                                                                                                                                                                                                                                             *msgl;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               cxif(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                          SIZE
                                                                                                                                             link *list;
                                                                                                                                                                                                                                                               直
```

```
remove_table: Deallocates the space used by the tableview manager.
                                                                                                    printf("TPM initialize error: invalid format (c)\n");
                                                  /* check for errors in processing */
                                                                          if (next_element < *size + 2)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   remove_table(table->next);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 /* end remove_table */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    void remove_table(table)
                                                                                                                                                                                                                                                                                      } /* end initialize */
/* end while */
                                                                                                                                                                                                         removelist(msgl);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   free(table->data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (table->next)
```

```
} /* end of strip */
/*****************************
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     printf("TPM delete error: invalid format (a)\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       printf("TPM delete error: invalid format (b)\n");
                                                    returns a ptr to the 'stripped' character string
                                                                                                                                                                                                                                                                                                                                                                                                                                                                  tmpdata = CALLOC(strien(data), char);
                             strip: removes the originator from a token.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  if ((getfromlist(tlist, &tdata, 2)) = 0) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if ( (getfromlist(tlist, &udata, 1)) = 0) {
                                                                                                                                                       ...
string = strip(token);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         answer = CALLOC(strien(data), char);
                                                                                                                                                                                                                                                                                                                                                                                               char *unpdata, *answer, *tdata;
                                                                                                                      char *string;
                                                                                                                                                                                                                    free string);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         dist = str2list(tmpdata," #");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            strcpy(tmpdata, data);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               strcpy(answer,tdata);
                                                                                                   typical call:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   strcat(answer,"");
                                                                                                                                                                                                                                                                         ***********
                                                                                                                                                                                                                                                                                                 char *strip(data)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                  link *list;
                                                                                                                                                                                                                                                                                                                       char *data;
```

```
strcat(answer, tdata);
```

/* clean up temp storage */ removelist(thist); free(tmpdata);

return(answer);

DATA CRUNCHING PROGRAM

```
print("CRUNCH usage error: crunch <max # of mbrs> mbrfile [outfile]n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               print("CRUNCH: attempt to open output file\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      printf("CRUNCH: attempt to open mbr file\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* open the output file (if necessary) */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                mbr_fd = fopen(mbr_file,"r");
                                                            max_mbr = atoi(argv[1]);
                                                                                                                                                                                                                                             max_mbr = atoi(argv[1]);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        out_fd = fopen(output, "a");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    /* open the member file */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    if (out fd=NULL)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (mbr fd = NULL) (
                                                                                        mbr_file = argv[2];
                                                                                                                                                                                                                                                                            mbr_file = argv[2];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         if (output != NULL) {
                                                                                                                                                                                                                                                                                                        output = argv[3];
                                                                                                                       output = NULL;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    out_fd = stdout;
 switch (argc){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    exit(-1); }
                                                                                                                                                                                                                                                                                                                                       break:
                                                                                                                                                        break;
                                                                                                                                                                                                                                                                                                                                                                                                   default
                                                                                                                                                                                                                   case 4:
                                  case 3:
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       else (
                                                                                                                                                                                                                                                                                                                                                                                                                                                           the output. Requires a group to grow to max size and then shrink back to
                                                                                                                                                 a single member. All failing members MUST be the acwnbr of the host.
                                                                                    * Description: gather all data generated by simpleapp, condense and dump
                                                                                                                                                                                                                                             * Usage: crunch <max group size> <file listing members> {<output file>}
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  char *mbr_file, *output, *cmd, host[10], type[6], type2[5], temp[3],
                                                                                                                                                                                                                                                                        NOTE: if <output file> is omitted, the output is sent to schout
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       #define CALLOC(n,type) (type *)calloc((unsigned) n,sizeof(type))
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            filename [10], subj(30], origin [30], grp_view [10];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            tax_mbr, i, index, skip, total, et, sum;
                                                                                                                                                                              i.e. the last member of the group.
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             FILE *mbr_fd, *out_fd, *test_fd;
                                                                                                                                                                                                                                                                                                                                                                                                * last revision: 26 Nov 1993
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              cmd = CALLOC(128, char);

    Written by: david pezdirtz

                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                #include <sys/time.h>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   #include <sys/filio.h>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         Finched < section >>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              #include <time.h>
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            *argv[];
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     long sec, usec;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   main(argc,argv)
```

float avg.

char **. E**

* Chuncher.c

```
for (\operatorname{skip} = 1; \operatorname{skip} <= (i \cdot \operatorname{index} - 1); \operatorname{skip} ++)
/* skip the appropriate # of lines */
                                                                                                                                                                                                                                          exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    fprintf(out_fd, "%s %d %s\n", output, max_mbr, mbr_file);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       print("CRUNCH: attempt to open 1%shn", filename);
                                                                                                  for (index = 1; index \Leftarrow max_mbr - 1; index \leftrightarrow){
                                                                                                                                                                                                                                      print("CRUNCH: reading member file\n");
                                                                                                                                                                                                     if (fscanf(mbr_id, "%s", host) = BOF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  for (index = 1; index \leq i-1; index ++)
                                                                                                                                                                      /* change to the mbr(index) system */
                                                                 * copy the files to the local directory */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* open the mbr(index) data file */
                                                                                                                                                                                                                                                                                                                                                                                                                                              streat(cmd, ":/tmp/timestamp ts");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       lest fd = fopen(filename, "r");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* total # of increasing changes */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              for (i = 2; i \leftarrow max_mbr, i++)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              sprintf(temp, "%d", index);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* print header to output file */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                               sprintf(temp, "%d", index);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    stropy(filename, "ts");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     streat(filename, temp);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (icst_id=NULL)(
                                                                                                                                                                                                                                                                                                                                                                              strcpy(crnd, "rcp");
                                                                                                                                                                                                                                                                                                                                                                                                             streat(cmd, host);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    streat(cmd, temp);
(seek(mbr_fd, 0, 0);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     system(cmd);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              sum = 0;
```

```
if (fscaniftest_fd, "%s%i%i%s", type, &sec., &usec, type2) = BOF){
                              if (faxant(less_id, "%s%i%i%s", type, &sec, &usec, type2) == BOF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            if (fscaniftest_fd, "%s%i%i%s", type, &sec, &usec, type2) == EOF)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (fscanfluest_fd, "%s%i%i%s", type, &sec, &usec, type2) = EOF
                                                                                                                                                                                                                                                                                                                     printf("CRUNCH: reading test file at %shn", host)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("CRUNCH: reading test file at %shn", host);
                                                                  printf("CRUNCH: reading test file at %shn", host)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 printf("CRUNCH: reading test file at %shn", host);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* parse the extra data for the agree recv */
                                                                                                                                                                                                                /* if agree init --> skip a line */
                                                                                                                                                                                                                                            if (strcmp(type2, "init") == 0){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     while (fgetc(test\_fd)!= 10){
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* skip the comit send */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               ct = sec * 1000000 + usec;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   /* read the data */
/* read a line */
                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); }
```

```
/* total # of decreasing changes */
                                                              if (facantitiest_fd, "%s%i%i%s%s%s", type, &sec., &usec, type2, subj, origin) == BOF){
                                                                                                                                  if (focantitest_td, "%s%i%i%s", type, &sec, &usec, type2) = BOF)
                                                                                                print("CRUNCH: reading test file at %shn", host);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                print("CRUNCH: reading test file at %shn", host);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     print("CRUNCH: attempt to close test file\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       avg = (float) sum / (float) (i - 1) / 1000000.0;
                                                                                                                                                                                                                                                                    /* parse the extra data for the agree recv */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         fprintf(out_fd, "=%d\text{Aavg} = %f\n", i, avg);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      ct = scc * 1000000 + usec - et;
  /* if agree init --> skip a line */
                            if (stremp(type2, "init") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      if (fclose(test_fd) = EOF) {
                                                                                                                                                                                                                                                                                                    while (fgetc(test\_fd)!=10)(
                                                                                                                                                                                                                                                                                                                                                                                                                                      /* read the comit send */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* compile the data */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* close the test file */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* average the data */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       /* output the data */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            Sum = Sum + Ct;
                                                                                                                                                                    exif(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        exit(-1); ]
```

for (index = 1; index <= \max_{max_m} mbr - i; index ++){

for $(i = 1; i \le max_mbr - 1; i++)$ {

sum = 0;

/* open the mbr(index) data file */

sprintf(temp, "%d", index);

strcpy(filename, "ts");

```
if (fscanf(test_fd, "%s%i%i%s", type, &sec, &usec, type2) == BOF)
                                                                                                                                                                                                                                                                                                                                                                                                     if (fscantitest_fit, "%s%i%i%s", type, &sec., &cusec, type2) = EOF) (
                                                                                                                                                                                                                                                                                                     for (skip = 1; skip \le (max_mbr + i - index - 1); skip++)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("CRUNCH: reading test file at %shi", host);
                                                                                                                              printf("CRUNCH: attempt to open 1%shn", filename);
                                                                                                                                                                                                                                                                                                                                                                                                                                        printf("CRUNCH: reading test file at %shr", host);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  /* parse the extra data for the agree recv */
                                                                                                                                                                                                                                                                     /* skip the appropriate # of lines */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* if agree init --> skip a line */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           if (stremp(type2, "init") = 0)
                                                                 test_fd = fopen(filename, "r");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              while (fgetc(test\_fd)!=10){
streat(filename, temp);
                                                                                               if (test_fd=NULL){
                                                                                                                                                                                                                                                                                                                                                                         /* read a line */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           exit(-1); }
                                                                                                                                                                                                   exit(-1); }
```

```
/* close the test file */
                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1); }
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            exit(-1);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            ii (focani(lesa_fd, "%s%i%i%s%s%s", type, Assec, Acusec, type2, subj, origin) == BOF)[
                                                                                           if (focantilest_id, "%s%i%i%s", type, &sec, &usec, type2) == EOF [
                                                                                                                                                                                                                                                                                           if (focunificat_iti, "%s%i%i%s", type, &sec., &usec, type2) == EOF)[
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          if (facanifliest_id, "%s%i%i%s", type, &sec., &usec, type2) == EOF)(
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            print("CRUNCH: reading test file at %sh", host);
                                                           print("CRUNCH: reading test file at %shn", host)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          print("CRUNCH: reading test file at %shn", host);
                                                                                                                                                                                                                                                                                                                            print("CRUNCH: reading test file at %shn", host);
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* parse the extra data for the agree recv */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              /* if agree init --> skip a line */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         ct = scc * 1000000 + uscc - ct;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        if (stremp(type2, "init") = 0)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          while (fgetc(test\_fd)!=10){
                                                                                                                                                                                                                                                                                                                                                                                                                                                             ct = sec * 100000 + usec;
* skip the comit send */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             /* read the comit send */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          /* compile the data */
                                                                                                                                                                                                                                                             * read the data */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              sum = sum + ct;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               exis(-1); }
                                                                                                                              cxif(-1); )
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             exit(-1); )
                                                                                                                                                                                                                                                                                                                                                                                              exis(-1); )
```

```
rind("07$$$$$$$$$$$$$$$\");
                                                                                                                                                                                                                                                                                                                    printf(out_fd, "i=%d\text{avg} = \text{%fn", (max_mbr - i), avg);}
                                                                                                                                                                                                              avg = (float) sum / (float) (max_mbr - i) / 10000000;
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               printf("CRUNCH: attempt to close output file\n");
                                  printf("CRUNCH: attempt to close test file\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                print("CRUNCH: autempt to close mbr file\n");
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        /* close the output file (if necessary) */
if (fclose(test_fd) == EOF) (
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             if (fclose(out_fd) == EOF) {
                                                                                                                                                                                                                                                                                                                                                                                                                                                              if (fclose(mbr_fd) = BOF) {
                                                                                                                                                                                                                                                                                                                                                                                                                            * close the member file */
                                                                                                                                                                            /* average the data */
                                                                                                                                                                                                                                                                                  /* output the data */
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               if (out_fd==stdout) [
```

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